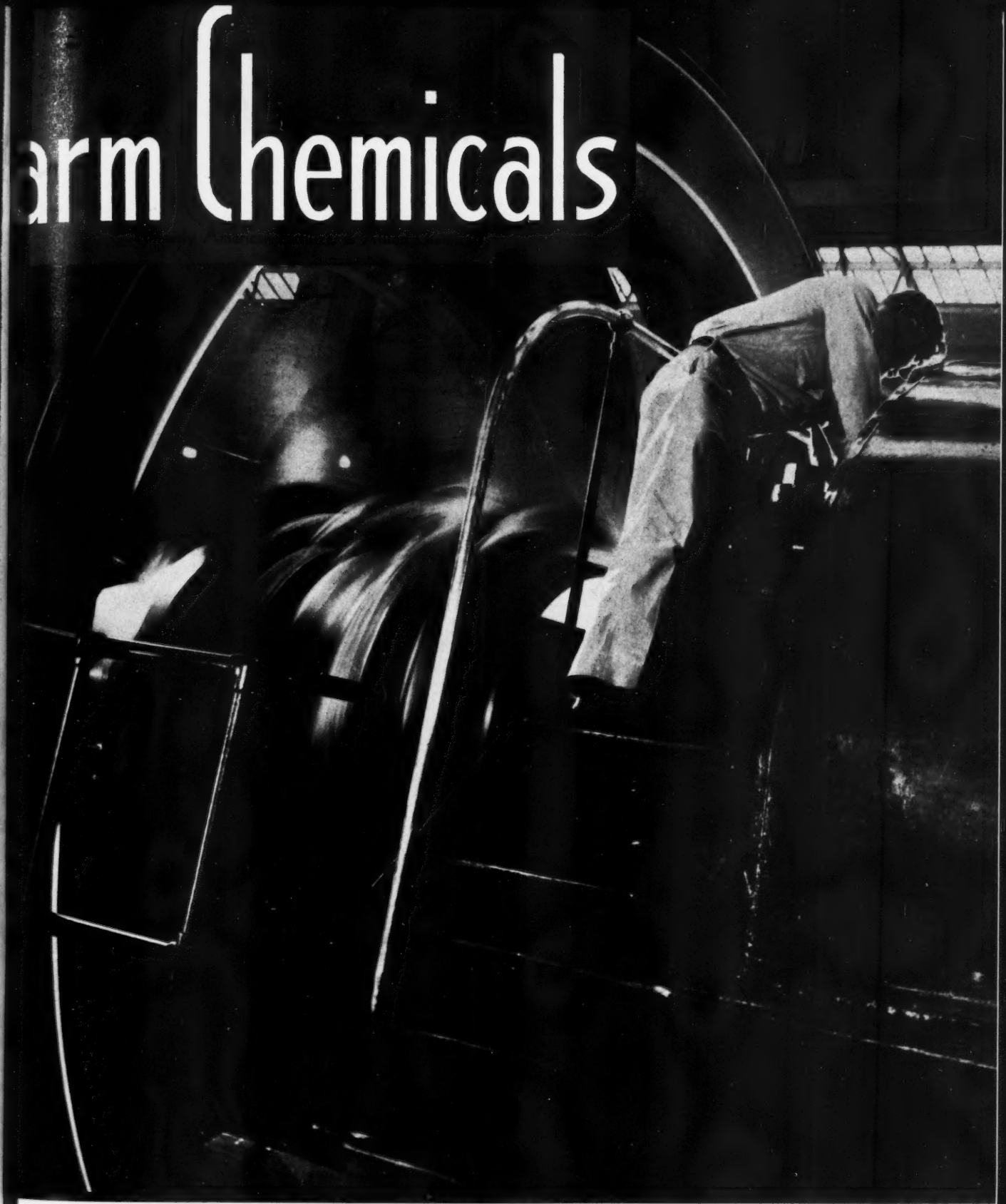
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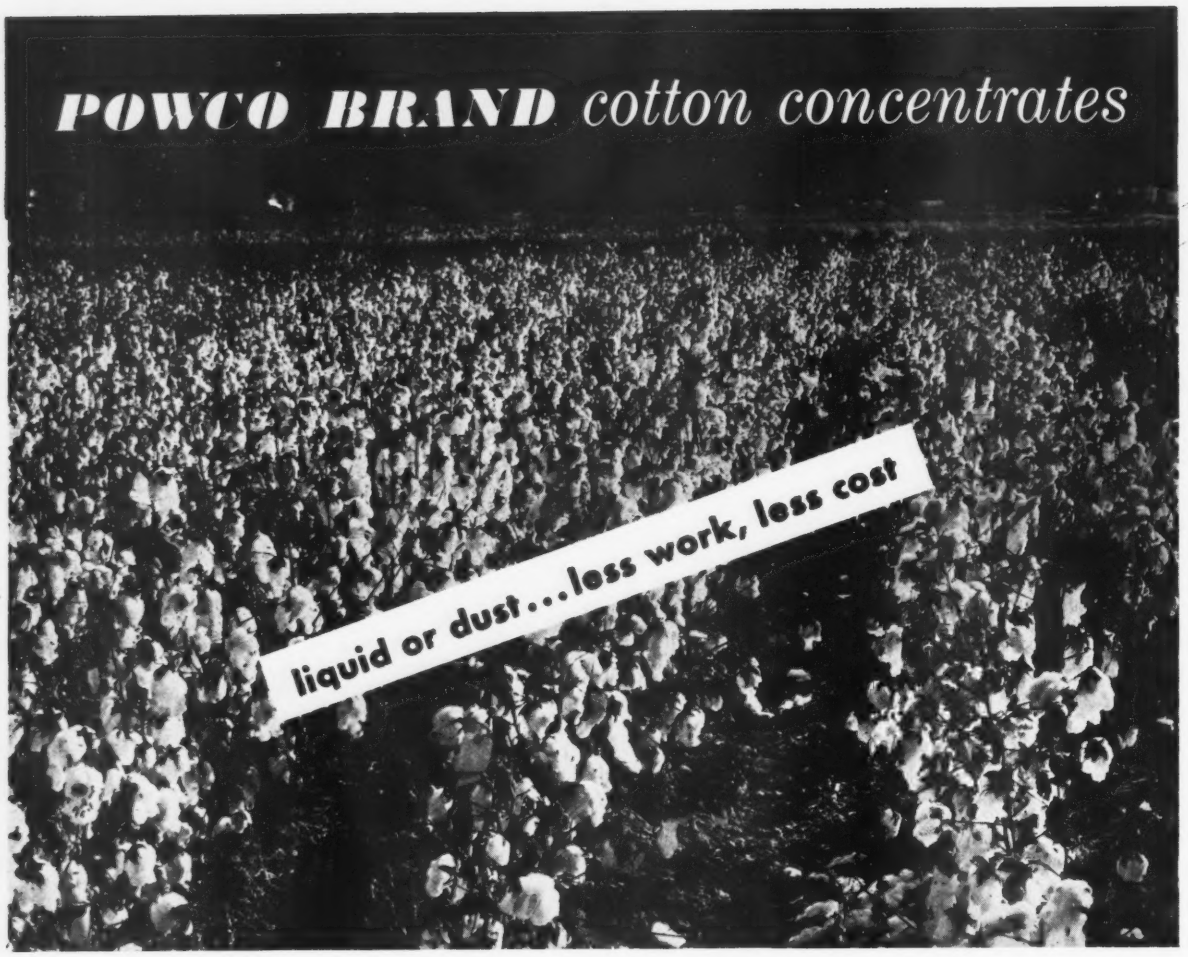
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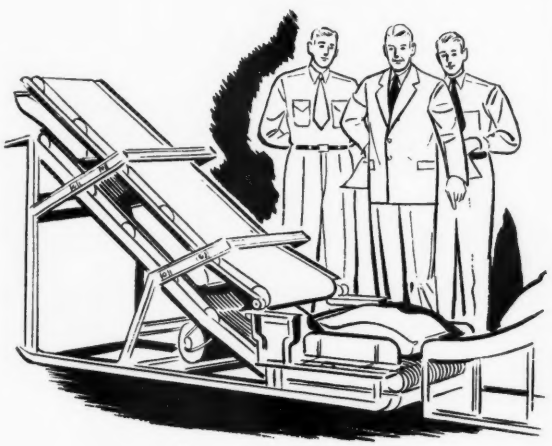
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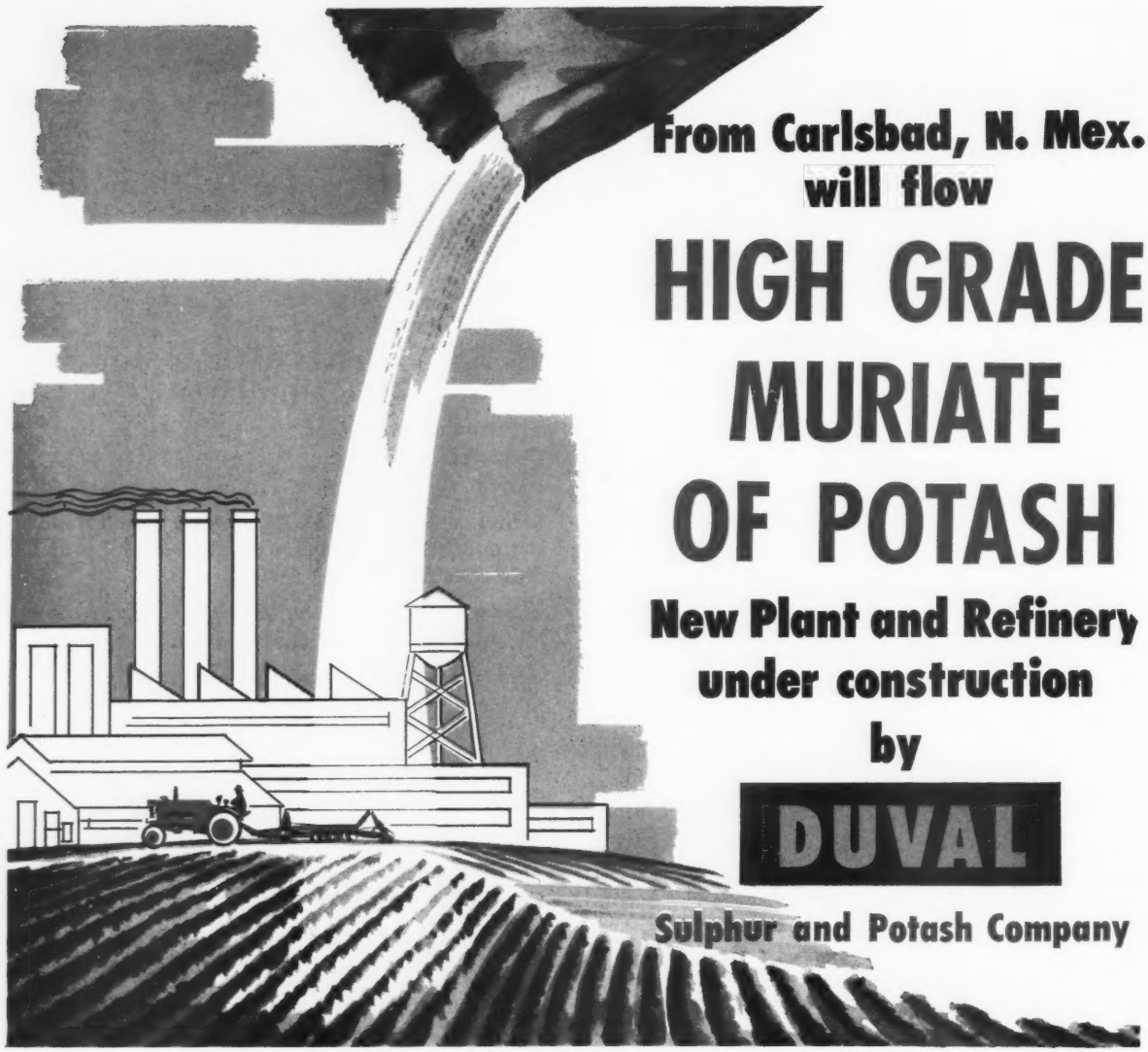
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DUVAL POTASH *FOR BETTER PRODUCTS OF FARM AND FACTORY*

In this issue . . .

Industrial personnel who've been trying to keep the weeds out of the company parking lot may have an answer to their problem in a new weed killer developed by DuPont. The material, called CMU, is a powerful herbicide that promises to have many industrial applications for railroads, highway departments and storage yards. The story of CMU and preliminary testing of the weed killer is told on page 12.

Real progress in the use of radioisotopes for experiments with soils and fertilizers has been made since the program was started in 1946. Recently papers were presented at the USDA's station in Beltsville, Md., to review the year's work in tagged element research performed in all parts of the country. For information on some of the experiments, supported in part by the fertilizer industry, read the article starting on page 15.

Several dozen recommendations for improvement or modification of pesticide controls were made during the course of voluminous testimony before the recent West Coast hearings of the Delaney committee, investigating the use of chemicals on foods. For a summary of some of the more pertinent suggestions for better regulations, see the story starting on page 21.

It's possible to manufacture fertilizers economically on the basis of water-soluble phosphoric acid by substituting nitric acid for sulfuric acid to counteract the sulfur shortage. That's the gist of a paper presented at the technical meetings of the International Superphosphate Manufacturer's Association meeting in Paris recently. For more details on the process, turn to the article on page 27.

Combining chemical fertilizers with an intelligent crop rotation system can help establish a sound and stable economy, Jackson B. Hester, of Campbell Soup company writes. He describes the method in the article on page 31.

If large hoppers and bins are necessary in your materials handling problems, you may be interested in the new vibrator described in the article on the last page of this issue.

farm chemicals

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PIONEER JOURNAL OF THE FARM CHEMICALS INDUSTRY

Vol. 115 **FEBRUARY, 1952** **No. 2**

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Cover Story

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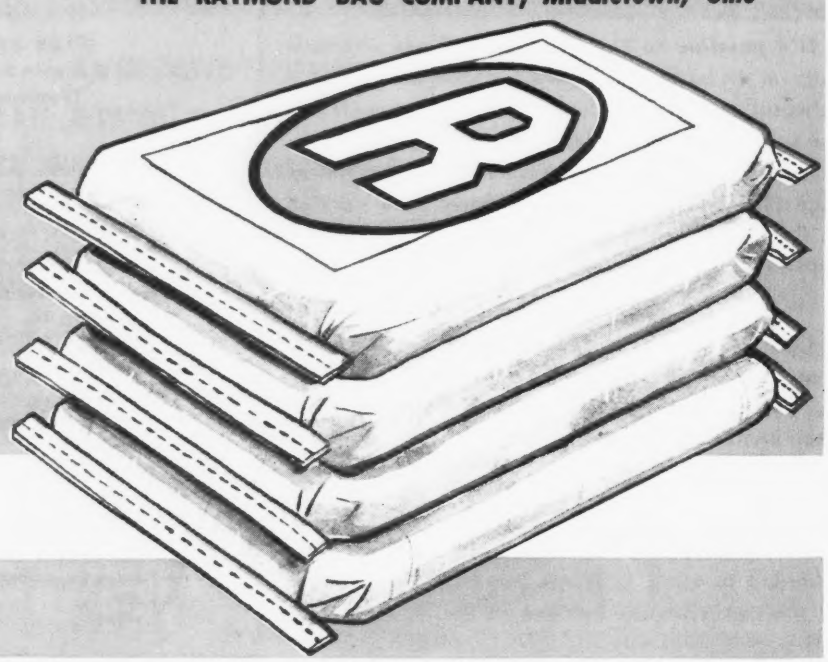
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farm chemicals facts

. . . Briefly Noted

Ingenious housewives in the Philippines are making shirts from cotton bags which bring fertilizer to their farms under the **Marshall Plan**. Although no word has been heard from Paris fashion designers, many American housewives are using the print cotton containers for dresses and other garments.

The **National Cotton Council** reports that several young Filipino boys have been photographed in their new shirts with this message still imprinted on the backs in red, white and blue—"Strength for the Free World from the United States of America."

A member of the team of scientists at **Charles Pfizer and Company, Inc.** who discovered terramycin, **Dr. Peter P. Regna,** has been elected a Fellow of the New York Academy of Sciences. Dr. Regna heads a research group at Pfizer which is working on the chemical structure of **terramycin**, the company's new anti-biotic.

Spencer Chemical company has started publication of a new house organ **"Today's Fertilizer Dealer."** The magazine will be published quarterly by the company.

Research in anhydrous ammonia, methanol and anti-freezes will be done by **John D. Kramer,** who joined the Dixie Research division of Commercial Solvents Corporation. Kramer will join other research chemists at the laboratories in Sterlington, La. A chemical engineer, Kramer is a graduate of Louisiana Polytechnic Institute in the class of 1950.

Died: Raymond C. Gaugler, president of American Cyanamid company, Jan. 10 at his home in Larchmont, N. Y. Before joining Cyanamid, Gaugler was with United States Aluminum company in New Kensington, Pa. and the Northern Aluminum company, Shawinigan Falls, Canada. He was elected president in January, 1951. He had been a director of **Cyanamid** since 1929.

J. Walter Harding, formerly traffic manager of Federal Chemical company, Louisville, has been appointed manager of purchasing and traffic. He has been with the firm four years.

Wyoming Gulf Sulfur plant at Cody, Wyo., now is in full operation, president **William Marquette** announced. First plant to get into operation in Cody county, Wyoming ships most of its products to Massachusetts and Oklahoma.

Construction of a 250-ton-a-day **sulfuric acid plant** on an 86-acre-site at Avon, Calif., is planned jointly by **Monsanto Chemical** company and **Tide Water Associated Oil** company. The plan will utilize waste sludge and hydrogen sulfide piped in from the Tide Water company refinery which is adjacent to the site of the new plant. Production is scheduled to start by the end of the year.

Most of the output will be piped to the Tide Water refinery for use in processing of **aviation gasoline** and other petroleum products.

Texas Gulf Sulfur company now is producing 300 tons of brimstone daily at its Worland, Wyo. plant, it reports. It processes hydrogen sulfide from natural gas produced by the **Pure Oil company** at the Worland field. The plant has a capacity of 400 tons.

Eugene P. Alexander has been transferred from **Chase Bag** company's Cincinnati territory to its Detroit sales office. Alexander is a sales representative for the company. His successor in Cincinnati will be **D. L. Herrick**, formerly of the Milwaukee branch of Chase.

Production of anhydrous ammonia at the Morgantown plant is scheduled to start early in March, **Mathieson Chemical** corporation reports. The company announced the appointment of **Joseph S. Whittington** as manager of agricultural sales for the Morgantown division. Whittington has been in the fertilizer business for more than 30 years, having served with Mathieson since 1949.

A **new production record** was established for the **domestic sulfur** mining industry in 1951, according to reports of producers to the Bureau of Mines, U. S. Department of the Interior.

Native sulfur production totaled 5,278,249 long tons, which was **2 per cent higher** than the 1950 figure. Reports show output exceeded 400,000 tons in every month, reaching the highest level in the third quarter.

Because of the sulfur shortage, stocks have declined to the point that sales in 1951 were 10 per cent below 1950.

Norman C. Weil was appointed **director of technical services** for **Solvay Process** division of Allied Chemical and Dye Corp. Weil replaces **Carl Sundstrom,** who retired at the end of 1951 after 52 years with the company. Sundstrom had been manager of technical services since 1938.

Weil formerly was manager of the chlorine and water supply group in the technical service department.

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Industry cooperation aids

'Tagged' Research

The report of soil and fertilizer investigations with radioisotopes in 1951 points up one major idea: the importance of cooperation between federal agencies and private industry in agricultural research.

The industry has a vital interest in the research work with radioisotopes. It has shown an appreciation of the importance of the work being done by the National Cooperative Research Program involving soil and fertilizer investigations with radioisotopes by working closely with the program since its inception in 1946.

The fertilizer industry's financial contribution to the program is not great—it is very small compared to the total appropriation—but it is essential to the success of the experiments.

When the radioisotope work was begun six years ago an Industry Committee on Radioactive and Tagged Element Research was formed, with Dr. Vincent Sauchelli, head of research at Davison Chemical company, as its chairman.

Purpose of the committee is to collect funds and to cooperate with federal and state research agencies in the program.

The work of this industry committee has received wide praise from officials of the United States Department of Agriculture.

Dr. F. W. Parker, of the USDA Bureau of Plant Industry, has stated that "industry's contribution continues to catalyze the entire program."

Industry contributions to the program since 1946 have been modest but important. In 1946, $12,000 was contributed; in 1947, $20,100; in 1948, $22,800; in 1950, $15,300, and last year, $16,000. That's not much compared to the total expenditures by government agencies of $235,000 in 1951.

But R. Q. Parks, of the USDA's Beltsville, Md., laboratories, stresses the importance of this contribution by industry.

Said Parks in a foreword to the year's work with radioisotopes, "Although the present industry support to this national program is small in comparison to the state and federal funds now being used, it is making possible several things that would be difficult to accomplish otherwise—for example, the annual regional review and planning conference. These meetings have made possible a rapid interchange of results and new findings so that full application of these can be included in the plans for the coming year."

"In fact," Parks declares, "these conferences have been the focal centers from which the program has developed."

Industry funds originally were used for purchase of specialized equipment needed to set up laboratories for work with radioactive phosphorus, and to train necessary personnel.

Now, however, the funds are used largely for the support of specific research projects at selected state agricultural experiment stations.

Ever since radioactive elements were made available, they have been an important part of agricultural research. Their chief value lies in the fact that they allow research chemists to determine exactly how chemicals are taken up and used by plants.

Through the device called "tagging," chemicals with radioactive isotopes can be traced through their cycle in the plant. The efficiency of farm chemicals thus has been measured accurately for the first time.

Work has progressed so far in the five years of research with radioisotopes that emphasis now is turning to a thorough study of the principles that have been established.

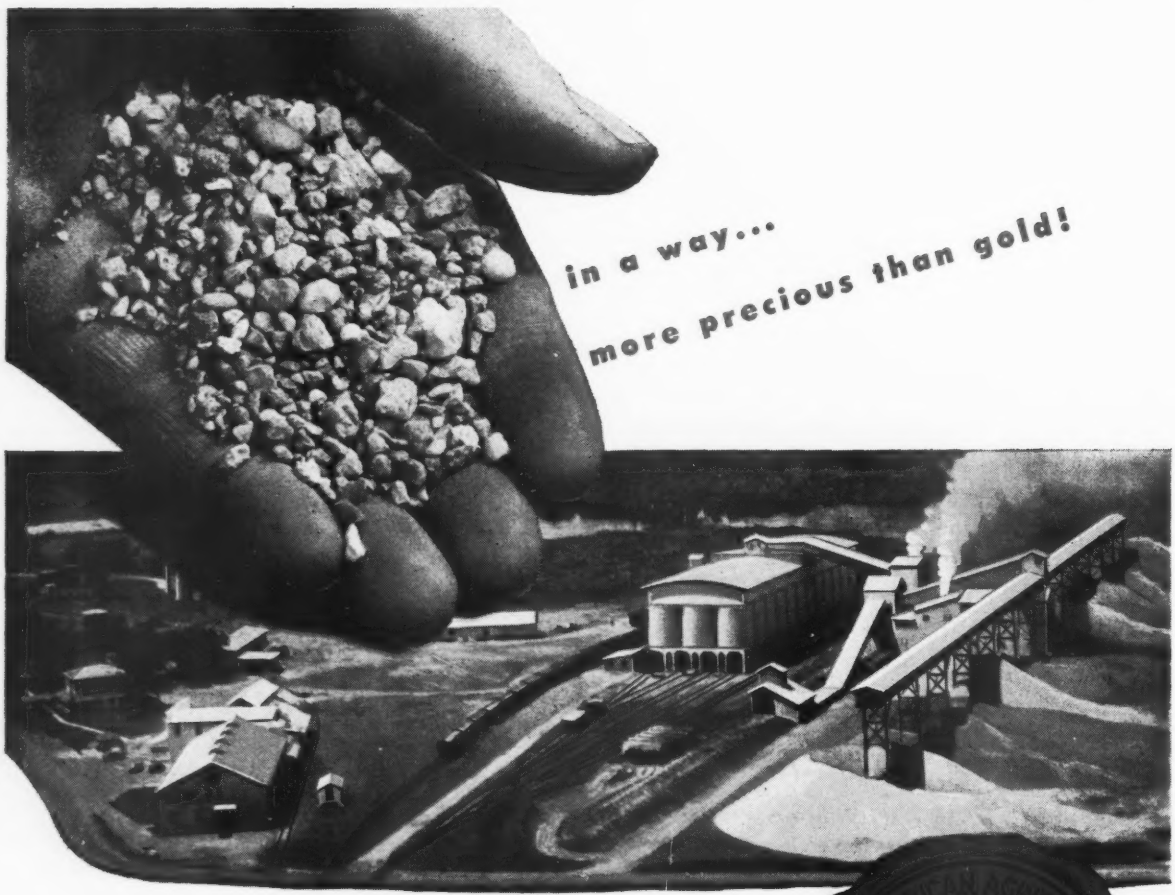
That was assured in a statement by L. A. Dean, principal soil scientist at the Bureau of Plant Industry station in Beltsville.

Dean, incidentally, did important research with Maurice Fried to determine the phosphorus fertility of soils.

So that information already gathered may be used more adequately, Dean said in an outline of experiments planned for this year that more controlled experiments will be conducted in greenhouses during 1952 to study established principles.

It is expected that the farm chemicals industry will continue its close cooperation with the program and thus will continue to gain important benefits from this vital research.

—Hamilton C. Carson



Air view showing dryers and rock storage at Pierce, Florida, headquarters of A.A.C. phosphate mining operations. (Top) Sample of Florida Pebble Phosphate Rock, source of phosphorus widely used in the chemical industries, in its elemental form as well as in phosphoric acid, phosphates and phosphorus compounds. ¶ This pebble rock is also the principal source of the most important—and most generally deficient—plant food element. Often called the Key to Life, phosphorus is essential in maintaining and improving crop yields. Health, growth, life itself, would be impossible without phosphorus . . . so in a way these phosphate pebbles are more precious than gold.

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farm chemicals outlook

Report from Washington
by Fred Bailey & Don Lerch

Mobilization is taking on new form. A plateau is in sight where the economy will digest the spectacular growth capsuled into the last year and a half.

Future expansion is being scheduled at a slower rate for many industries. Coupled with this will be the mounting rate of production as industry catches up with the backlog of orders placed by the government. It adds up to doing business in an enlarged fortress.

Most mobilizers believe we have the productive capacity in sight to block further Russian moves short of full-scale war. In other words . . . enough to play the deadly game of miniature war but without dipping into the atomic stockpile.

Complete change of the master blueprint could come almost over night, but the prevailing opinion in Washington is to give the country a breathing spell. Part of the reason is politics . . . part is the fear that if we hurry down "armament lane" too fast there will be no turning back. There is still considerable hope for a prolonged but uneasy peace.

Guns and butter are the goal of the planners in spite of some reports to the contrary. For one thing, there is tremendous pressure from labor organizations to keep civilian industry going wherever possible in order to cut growing unemployment in certain areas. Furthermore, Washington can't see the end of mobilization and for the long pull civilian production will be maintained at the highest possible level.

Advocates of an 85-billion dollar military budget are still fighting, however. Right now they have been over-ruled but their backers are busy setting the scene for favorable action when another crisis arrives. Present military budget is about 40 per cent less.

Optimists in official circles believe that by mid-1952 nearly all essential civilian needs will either be in the stores or on the production line. Those "real shortages" generally predicted for this year may not show up. Washington hopes the prospect of good supplies of most items will prevent "panic buying" particularly of durable goods.

The inflation curve is expected to continue the gradual climb of recent months, rather than take a sharp general upturn. Officials base this feeling on a "spread-out" defense production program which will not pinch materials for the civilian markets as much as had been feared . . . and the gamble that farmers will be able to turn in another year of record production.

Creeping inflation is expected as the rate of defense spending slowly rises. The government is planning to write checks for military equipment in the 1953 fiscal year, totaling 15 billion dollars over the current rate. "Inflation on the installment plan" is the way some observers see it. Assuming that taxes are not further increased in the meantime, this would mean a deficit of 10 to 12 billion dollars.

Congress is talking economy but there is little likelihood of substantial cuts. Military appropriations and aid to our allies take 73 per cent of the budget and Congress doesn't have time for major surgery.

Veterans' benefits and interest on the national debt can't be cut. The civilian

budget, amounting to about eight per cent of all expenditures, probably will be shaved a little but no big cuts are in sight.

Even with the two major farm organizations advocating cuts in ACP payments to farmers for conservation practices, it is doubtful that any sizeable reduction will be made.

Both the National Grange and the American Farm Bureau are on record against ACP payments. General feeling is the program is too deeply rooted to tear up in an election year.

Fertilizer industry appears well along the way toward supplying farmers with record amounts of plant food. USDA officials have been caught by surprise at the estimates of super-phosphate production. Early forecasts of a drop of 8 to 10 per cent constantly are being revised.

Some believe there is a chance the industry may equal last year's production of phosphate. Washington attributes this mainly to the industry's resourcefulness in obtaining and reclaiming acid and other forms of sulfur. Nitrogen and potash production are estimated at five per cent above a year ago.

Washington's long-range expansion program for the fertilizer industry calls for substantial increases by 1955.

USDA officials are making detailed studies based on expected population, acres under cultivation, export requirements, land capability, and farmers' habits.

New increases for the industry in 1955 compared with 1951 are: nitrogen 70 per cent; phosphates 56 per cent; potash 52 per cent. This is what the USDA will support and push for adoption.

Present nitrogen expansion program is moving satisfactorily by Washington standards. Material allocations, tax certificates, etc. are all reported in hand.

Pinch, if any, is forecast for the third quarter of 1952 when most of the "starts" are expected to go through.

Washington is receiving some gloomy reports of distribution trouble. Some fertilizer men here are going through the usual case of "spring jitters." There is no reported rush by farmers to buy fertilizer so far, however.

New research project on insects in small grains approved by Congress last year is just getting under way. Program is financed with a $40,000 grant to BEPQ. Research will be carried on cooperatively with agricultural colleges and other State agencies.

Huge losses to greenbugs for the last two years touched off agitation for the program. Farmers are estimated to have abandoned two and one-half million acres of wheat in Oklahoma because of greenbug damage during 1950. BEPQ figures over a million acres were destroyed last year.

Scientists will center their work on developing improved cultural methods, resistant varieties, and chemical control, including study of systemic insecticides. Dr. R. G. Dahms, greenbug research specialist of BEPQ, heads the new project.

Watch for USDA's report of the county-by-county survey of pesticide use. Some data should be available in February.

Survey will show estimates of last year's usage and this year's requirements. USDA depends heavily on these surveys to bolster requests for the allocations of essential requirements for the industry.

Continued fumbling of the Mexican farm labor agreement has many cotton growers jittery. Negotiations between the U.S. and Mexico were deadlocked for months. Always a touchy subject, the "wet-back" issue looms as one of the major stumbling blocks to high-level cotton production in several key areas. Growers are pleading for definite action before planting time.

Shortage of labor, rather than scarcity of materials, may be the limiting factor in 1952 farm production. USDA's revised goals call for the cultivation of six and a half million acres over 1951, with emphasis on feed grains. For clues on planting intentions . . . keep a close watch on the supply of labor.



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Du Pont has developed a powerful new herbicide with wide industrial uses. The weed killer is called—

CMU

A new and powerful herbicide with important applications as a sterilant for industrial uses has been developed by Du Pont.

Named CMU, the weed killer may go a long way toward solving the ever-present problem confronting railroads, highway departments, telephone and power companies where it is essential that weeds be eliminated.

These industries spend thousands of dollars every year for maintenance of right of ways. This consists in keeping railway road beds free of weeds to preserve ties and roadbed and prevent fires, keeping areas around telephone and power poles unobstructed and free of vegetation.

The material will also have considerable application in lumber yards, parking lots and storage areas.

The importance of CMU has been emphasized by tests showing it will keep soil free of plant life up to 18 months with applications of 20 to 80 pounds per acre.

In addition, preliminary tests with CMU indicate that when applied lightly—at rates of from one-half to five pounds per acre as a pre-emergence treatment — it can selectively eliminate harmful weeds without injuring the crops.

Many potent weed killers have been developed in recent years, but, because of the small amount of CMU necessary to control vegetation and its promise as a potential selective killer of weeds in crops, its advent has special significance.

Sterilants generally are divided into three types: 1. Temporary, persisting for a period of four months or less; 2. Semi-permanent, persisting up to two years; and 3. Permanent, more than two years.

Since tests have indicated that weed control with CMU at reasonable rates can be maintained for up to 18 months with one application, it can be termed a semi-permanent sterilant.

No conclusive testing has as yet been done to determine its value for permanent sterilization.

Many herbicides have been produced for semi-permanent sterilization since the first large scale work in weed control was started in the thirties, but most have one or more drawbacks.

Sodium Chlorate

Sodium chlorate, for example, is quite effective under most circumstances. A strong oxidizing agent, it acts as a contact poison on plant tissue, serves as a translocated herbicide and kills plants by root absorption. The extreme fire hazard which is associated with its use is sodium chlorate's principal disadvantage.

Because of the many limitations of translocated sprays, treatment with sodium chlorate is more reliable for eradicating deep-rooted perennials, because the regenerative organs themselves are directly exposed to the chemical.

Arsenic, too, has value as a herbicide, but its toxic qualities make it dangerous. Many workers have been made ill while applying arsenic and many livestock deaths have resulted from eating of vegetation sprayed with the substance.

In recent years boron compounds have been used with success to combat weeds. The toxic nature of these compounds to plants long has been known to chemists, but their herbicidal application is of comparatively recent origin.

Excellent Results

CMU, the newest herbicide in the field, gives promise of excellent results as a soil sterilant at moderate application rates.

Chemically, CMU is the abbreviated name given to 3-(*p*-chlorophenyl)-1, 1-dimethylurea.

It is a white crystalline compound with a melting point of approximately 171 degrees C. Solubility of CMU in water and in most organic solvents is very low, approximately 230 ppm in water at 25 degrees C. It is a neutral, stable substance and is neither corrosive nor flammable.

The weed killer has been formulated into a wettable powder which contains 80 per cent by weight of the active ingredient.

Tests made with applications of CMU on railroads have shown that under most conditions 20 to 40 pounds per acre is sufficient to give satisfactory control. In some cases, however, up to 80 pounds were necessary for satisfactory results.

Length of control period is

effected in part by soil type, soil moisture, *p*H and amount of rainfall.

The more delicate problem of selective killing of weeds also has been studied extensively by Du Pont chemists.

Data indicates that when CMU is applied at rates of from one to five pounds per acre as a pre-emergence treatment in crops, weeds may be controlled from two to six months.

Particular promise of weed control in sugar cane, cotton, corn, asparagus and carrots is seen through CMU applications.

CMU's Persistance

Persistance of the new chemical in various soil types and under various rainfall conditions is a question still facing research workers at Du Pont.

The company is developing a method of tissue analysis which will be helpful in determining the presence of CMU in plant parts.

The chemical usually produces initial symptoms in the form of dieback of leaf tip and a burn of the leaf edges. This starts on the older leaves and is followed by progressive chlorosis and retardation of growth, ending with the death of the plant.

Dr. Wolf described the herbicide at the eighth annual North Central Weed Control Conference in Oklahoma City and reported that rainfall has a marked effect on the action of CMU.

He explained that in Texas, a drought period lasting three months followed application of CMU to Johnson grass. The herbicide had no marked effect on the vegetation during the drought but after a rainfall the plants soon died.

More detailed information on the effect of precipitation on herbicidal efficiency when CMU is used in either pre- or post-emergence applications is being sought through continued testing, he said.

Dr. Wolf said methods of micro and macro analysis for the weed killer are being developed. Agricultural chemists will be interested in the micro method because it will enable them to determine how much CMU is retained in the soil.

Initial toxicity tests conducted by the DuPont Haskell Laboratory of Industrial Toxicology indicate that the LD_{50} of CMU by oral administration to male rats is approximately 3500 mg./kg. of body weight.

By comparison, 2,4-D has an acute oral toxicity of approximately 700 mg./kg. indicating that it is approximately five times as toxic as CMU, when taken orally.

Chronic Toxicity

Chronic toxicity information is not conclusive and will be gained after completion of feeding experiments now being conducted. No skin irritation has been noted on guinea pigs that underwent an application of 33 per cent CMU aqueous paste, the research biologist added. No instance of skin sensitization was noted.

CMU has been tested widely by state and federal investigators in every state in the United States and in Canada, Hawaii, Puerto Rico and Alaska. Limited trials have been made in Great Britain, Honduras and Sweden.

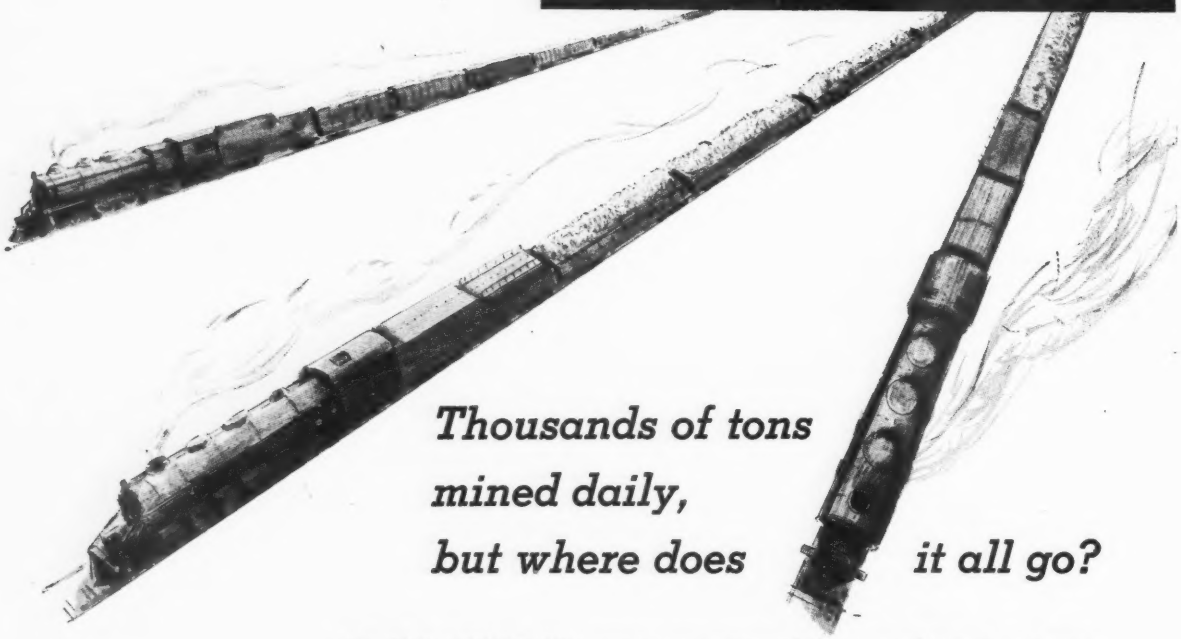
The new weed killer is available this year for industrial application only. DuPont expects the place of CMU in important weed control practices, especially as they apply to agriculture, to be more clearly defined after another year of field testing. ◆

Here's how CMU weed killer cleans up heavy grass and weed growth. Note the line where CMU treatment was stopped along the railroad track, and the thick growth of grasses and weeds in the untreated area in the background. This was a late spring application, at rate of 40 pounds of 80 per cent CMU per acre. Photo taken four months after application.



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Chemists from all sections of the United States report on their experiments with

Radioisotopes

The importance of using radioactive elements in agricultural research was recognized in 1946. Since that time investigations into soils and fertilizers with radioisotopes have been conducted by the National Cooperative Research Program with the close cooperation of a fertilizer industry committee on radioactive and tagged element research.

Progress was slow at first but during 1951 the program had a big year. That progress is displayed in a year's end review of reports on radioisotope investigations in 30 states and a Canadian province. The reports were presented at the Bureau of Plant Industry Station, Beltsville, Md. recently for the benefit of the fertilizer industry.

Representatives from all parts of the United States presented reports on a specific topic which typified the developments that have been made through the use of radiophosphorus.

Three Papers

Included in the review are papers on the use of radio phosphorus to determine the phosphorus fertility status of soils, and in studying minor element deficiency and chlorosis. Another deals with the influence of fertilizer material and placement on utilization of fertilizer phosphorus by crops on calcareous soild.

Dr. L. A. Dean and **Dr. Maurice Fried,** principal soil scientist and soil scientist, respectively, at the Bureau of Plant Industry, who devised the "tracer technique" for precise measurement with radioisotopes presented a paper on the first topic, phosphorus sterility in soils.

The soil scientists have used the tracing technique, which rests on the concept that a plant with two sources of a nutrient will absorb from each in direct proportion to the amounts available, to study plant absorption of phosphorus. Their report follows:

Early Experiments

In the past field and greenhouse experiments with radio phosphorus primarily have been used to study the utilization and efficiency of the use of phosphatic fertilizers added to soils. Since it has been observed that the relative proportion of soil to fertilizer phosphorus absorbed by crops is related to the amounts of available phosphorus in soils, the possibility of using these experiments with fertilizers labeled with radio phosphorus to evaluate the phosphorus fertility status of soils has been investigated.

If it can be assumed that a plant, when it is presented with two sources of phosphorus, namely, the soil and the fertilizer, will absorb phosphorus from each in proportion to the amounts available, then it is possible to formalize this into a basis for determining the amount of available phosphorus in the soil, as follows:

$$\frac{A = B\,(1-y)}{y}$$

where A = Amount of available phosphorus in the soil
B = Amount of phosphorus in the fertilizer and
y = Proportion of the phosphorus in the plant derived from the fertilizer.

In short, in this method for determining the amount of available phosphorus in soils, 'A' value embraces introducing a known amount of phosphate fertilizer labeled with radiophosphorus into a soil, growing the desired crop, determining the proportion of the phosphorus absorbed that was derived from the fertilizer and calculating the amount of available phosphorus in the soil using the equation given above.

Soil Phosphorous

This measured amount of soil phosphorus is in terms of the fertilizer used. For example, if superphosphate were the fertilizer, then the 'A' value is in terms of the amount of phosphorus in the soil which is as available as the superphosphate added. The greenhouse data given in the table serves to illustrate the foregoing discussion.

Two soils are compared, a Davidson soil low in available phosphorus

and a Caribou soil which was well supplied. They were fertilized with superphosphate containing radiophosphorus and a crop of oats grown.

The increase in yield on the Davidson soils is further evidence that this soil was phosphorus deficient. As was expected the per cent of phosphorus in the crop derived from the fertilizer varied with the rate of application and was highest for the soil that was deficient in soil phosphorus. The 'A' values calculated from this data are largely independent of the rate of application and are an evaluation of the amount of available phosphorus in the soil.

A series of uniform phosphorus field experiments designed to test the usefulness of 'A' values as a measure of the phosphorus fertility status of soils were conducted during the past year.

70 Experiments

A total of 70 of these experiments were conducted in 24 States and Canada. The uniform experiments were of simple design with only 24 plots involving 0, 20, 40 and 80 pounds per acre rates of P_2O_5 as double superphosphate and 6 replications. The superphosphate used for the 40-pound rates was labeled with radiophosphorus, thus making possible a determination of an 'A' value for all locations.

The crop grown varied with the region. In the west it was spring wheat, in the North Central and Northeastern states it was oats, while in the South cotton was grown.

Soil samples from all locations were sent to Beltsville and a greenhouse experiment paralleling the field experiments was conducted on all soils. Thus the yield response and 'A' value for all soils was determined in both the field and greenhouse.

In order to test the usefulness of 'A' values as a measure of the phosphorus fertility, status of soil correlations between these values and yield response for both field and greenhouse were examined. These studies have shown the 'A' values for soil phosphorus to be well correlated with yield response and that they will serve as a good basis for predicting the behavior of crops on soil receiving phosphorus fertilization.

The soils which were used in the experiments described above are available for further investigations. There is interest using them for the calibration of the chemical soil testing methods now in common use.

Among fundamental studies in progress is a project to learn what happens in plants affected with chlorosis (yellowing of leaves). **Dr. S. B. Hendricks,** head chemist at the Bureau of Plant Industry, discusses this in the second report. The problem, a serious one in crops on calcareous soils in the West, is related to the function of iron in the plant. Dr. Hendricks describes the background of two research approaches to this problem.

Iron Isotopes

In one, **C. E. Hagen** is using iron isotopes in an attempt to determine the plant part in which the chlorotic disturbance occurs.

Dr. J. C. Brown is exploring the possibility that minor element deficiencies causing chlorosis are reflected in decreased enzyme activity that will reveal chlorosis in early stages, and make it possible to correct the deficiency before the chlorosis becomes acute. Text of the paper follows:

There are about 10,000 references in the "Bibliography of the Literature of the Minor Nutrient Elements" publication of which we are indebted to an industrial group —The Chilean Nitrate Educational Bureau. This represents an immense amount of work chiefly in the period since 1900. It can be summarized, however, quite simply

'A' Values Calculated from a Greenhouse Experiment with Oats

Soil	(B) Superphosphate Applied	Yield	(100 y) Phosphorus in Crop Derived From Fertilizer	B (1-y)/y Available Phosphorus in Soil 'A' Value
	lbs./A	gm./pot	percent	lbs./A
Davidson	0	1.6	—	—
	40	2.6	28.8	99
	80	3.0	44.0	104
Caribou	0	4.6	—	—
	40	4.9	7.2	521
	80	5.0	12.9	541



Test above shows lime induced chlorosis on three varieties of lupines. They are yellow in the front row, blue in the middle and white in the back. The soils in column one are Michigan muck and column four a naturally calcareous soil from Utah showing the lime induced chlorosis. Numbers two and three are mixtures of muck and the calcareous soil; two containing two-thirds muck and three—one-third. Note that the lupine varieties vary in sensitivity to chlorosis and in the extent to which this chlorosis is ameliorated by addition of muck.

as indicating that the six elements boron, iron, manganese, copper, zinc, and molybdenum are essential for plant growth—probably for all plants.

Important Questions

The indication that one or another element is essential for plant growth is a noteworthy discovery but it is the merest beginning of the subject. The next questions are: (1) What is the nature of the supply of the particular element from the soil to the plants? (2) How does the element pass into the roots? (3) What is the function of the element in the plant and how does it interact with other elements? (4) Is the element adequately functioning in the nutrition of the plant?

Perhaps the last of these questions is of most interest to the fertilizer industry and to those concerned in growing crops.

In brief, they are practically a necessary tool for work in the subject and the handicap is tremendous in a case such as boron where the half life is too short for use. The other five elements have half lives suitable for isotopic tracer work.

Brown's basic postulates are: 1. In the case of a minor nutrient element which functions as a necessary part of some enzyme, and they all do, the nutritional status of the plant is shown by the level of activity of these enzymes. 2. For a particular element one enzyme is likely to drop in amount before some of the remainder. If this enzyme can be found it will best serve as the activity index for the element in the plant.

Brown has been so fortunate as to find an example from his first work in the field. It is with regard to copper. This element takes part in enzymes required for oxidation of polyphenols, and vitamin C—that is, ascorbic acid oxidase. Copper deficient wheat, okra, tobacco and other plants were grown on a Michigan muck.

Activity Drops

In each case the activity of ascorbic acid oxidase dropped profoundly. In tobacco, for instance, which showed none of the watery spots indicating the deficiency but was somewhat retarded in growth, the ascorbic acid oxidase had dropped to about one-tenth the normal activity. That the amount of copper is reduced in such tissue can only be found by very careful analysis. At the best copper is lowered only by about 25 per cent and in the literature there are many examples of analyses showing an increase of total copper in copper deficient plants.

Tobacco Division

Next, Brown went to the Tobacco Division, in which his work long has been carried out with minor nutrient elements. Dr. Steinberg had tobacco growing deficient in boron, zinc, manganese, iron and molybdenum. Those deficient in boron, zinc, and iron were essentially normal in ascorbic acid oxidase. Only those deficient in molybdenum and copper were markedly low.

The level of ascorbic acid oxidase is a sensitive indicator of the functioning of copper in tobacco. It is quite likely in the future, probably within a decade, that normal appearing plants will be assayed for adequacy of the element by the activity of this enzyme. Dr. Brown is obviously faced with a great divergence of paths that he can follow and it is to be regretted that such work has not even one

per cent of the workers needed to develop the subject.

In contrast to the above Hagen looks upon the supply of the element in a form suitable for making the enzyme as a limiting factor. The basic postulate here is: a minor element is inadequate for normal nutrient plant growth when its supply is so low as to limit its incorporation into enzyme systems.

Hagen's Work

The problem used as an example of Hagen's work is chlorosis. This, of course, is a common disorder of plants associated with the inadequacy of chlorophyll and generally caused by incorrect functioning of iron. This is surely not new or provocative. But progress is being made if the question is asked as to how a plant has any iron for its functioning even in the normal case. At the acidity of the plant sap the iron immediately will precipitate unless something is around to form a complex ion to hold it in solution.

Some of these ions are familiar in the blood red solutions of ferric citrate and of the enhanced solution by metaphosphate, versene, etc.

Hagen argues that in order to function the iron has to partition between the many things in a plant that can tie it up. Between citrate, acetate, the metaphosphate groups of chloroplasts and other groups.

Chlorosis is thought to arise when the pattern of partition is upset. He measures the partition pattern with radioactive iron and finds that in chlorotic plants the cytoplasm of the cells contains compounds that withhold the iron from the plastids.

In normal plants the plastids contain about 80 per cent of the iron but in chlorotic plants this will be reduced to as little as 50 per cent, the remainder being held in soluble complexes. This is progress, but it leaves unanswered whether or not one is still dealing with a cause or result of chlorosis.

In the third paper, **Dr. H. B. Peterson** professor of soils, Utah Agricultural Experiment Station, has presented evidence that indicates water soluble phosphates such as superphosphate are superior to other materials in availability. Dr. Peterson presents new knowledge of crop plant response to different phosphatic materials and to various types of placement on calcareous soils in the West in the following paper:

The soils in our western area are highly variable. There are many of these soils which contain no free lime and yet are not acid in reaction. The calcareous soils vary—lime content of from 50 per cent to only minute amounts. Not only do the soils vary in the amount of lime contained but also in the form or activity of that lime. Most contain a large amount of total phosphorus.

Phosphate fertilizer usage is relatively new in the area. The research on the phosphate materials has been inadequate. In a review made about three years ago it was shown that very little was known about either placement of phosphate or the relative value of the different materials for calcareous soils. We have been forced to rely on work done on acid soils for our information which we now know is not entirely satisfactory for our conditions.

Few Trials

To many it has appeared that it would be easy to solve the problems with a few field trials. This has not been so. Often no response to phosphate was found and no evaluation could be made of either placement or materials. Even where a response was obtained in the form of increased crop yields the results were variable and the evidence conflicting.

During the last three years much valuable information has been obtained. This has been due largely to: 1. research funds made available by the Fertilizer Industry; 2. the close cooperation of workers through research committees and 3. incorporation of radioactive phosphorus in the different fertilizer materials.

With the tagged fertilizer it is possible to measure the amount of phosphorus in the plant that comes from the added fertilizer. This gives a measure of the relative effectiveness of the different materials or the different placements; whichever is being studied.

The data from placement tests in several states represent examples of the work done. The general tentative conclusions are as follows:

1. Neither band placement, broadcasting nor incorporation with the plow layer of the soil is superior.

2. The superiority of one method over another depends on many variables such as crops, moisture conditions, fertility status of the soils and time of application.

3. Fertilizer mixed with the soil is not fixed to the extent that it is unavailable to the plants.

4. Mixing of the fertilizer with the soil such as is done by broadcasting the fertilizer and plowing or disking the land, is particularly effective on very deficient soils during early plant growth. The early stimulation does not always persist until the time of harvest.

From comparisons made as to the relative availability of different materials the following conclusions seem justified: 1. That superphosphate = double superphosphate = phosphoric acid = ammonium phosphate (11-48-0) > calcium meta > dicalcium > tricalcium phosphate. 2. The availability of calcium meta phosphate increases as the material is reduced in particle size. 3. Nitric phosphate appears (in a limited test) to be equally available to the water soluble fertilizers. 4. Rhenania phosphate (heated soda ash and rock phosphate) when finely ground is available to the plants.

Order Unchanged

5. The order of relative availability is not changed for different crops at least for the limited number of crops tested. 6. One material such as phosphoric acid which is applied in the irrigation water, may have an advantage over other materials for specific conditions.

The conclusions drawn from placement trials and comparisons of materials are for one season only. Residual values have not been evaluated because the half-life of the radioactive fertilizer is such that the material is useful for only one season.

Tests are under way in which the effect of moisture on the availability of phosphorus is being evaluated. A project has been approved in which the effect of ammoniation of superphosphate (single and double) on the availability of the phosphorus is being determined. ◆



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Speakers at west coast Delaney hearings offer suggestions for improved

Pesticide Controls

WHEN the Select Committee to Investigate the Use of Chemicals in Foods and Cosmetics held hearings in Washington and California recently, a vast amount of testimony was presented on the subject, particularly as regards the use of pesticides applied to fruit grown in the Northwest.

Most of the chemical and agricultural leaders who spoke before the hearing defended the use of pesticides on fruits and vegetables as necessary for large scale production in our expanding economy.

Two, however, presented evidence which they declared showed the harmful effects of DDT and other chemicals on persons using them or consuming food treated with them.

The pros and cons of the argument were presented in the first article on the West Coast hearings in the January issue of Farm Chemicals.

There were almost as many suggestions for the regulation of chemicals on food as there were persons testifying before the Delaney committee.

Several spokesmen said they thought present restrictions and regulations, if properly enforced and carried out, were sufficient.

Others were of the opinion that further regulations were needed or that existing ones needed modifying. In the following exerpts from statements before the committee, the proposals are presented for the farm chemicals industry to consider.

Robert L. Webster, Ph. D., *State College of Washington:*

It is my opinion that the Federal Food and Drug Administration has ample authority under present legislation to meet the problems involved in the hazards of human health following the use of insecticides.

This authority is contained in the Pure Food Act of 1938 and in the Insecticide, Fungicide and Rodenticide Act of 1947. Amplification of this authority beyond its present scope, in my opinion, will result only in delay in the use of new materials or combinations and work undue hardships in the production of many crops where insecticides are necessary in order to produce foodstuffs free from insect contamination and fit for human consumption.

Robert L. Metcalf, Ph. D., *chairman of the division of entomology, University of California Citrus Experiment Station:*

No new insecticidal material has been licensed for use on citrus in California without at least three seasons of investigational work involving the application of several tons of insecticide on plots numbering in the thousands of acres.

The information obtained is supported by hundreds and usually thousands of chemical determinations of insecticide residues on and in produce and by-products at harvest.

The final decision as to the ultimate safety and efficiency of the new insecticide to the grower and consumer is made only after close consultation with the Bureau of Chemistry of the California State Department of Agriculture with the U. S. Department of Agriculture, with the Food and Drug Administration and with the California Fruit Growers Exchange, Mutual Orange Distributors and other marketing organizations.

Therefore it is our considered opinion that the present system of registration and licensing of agricultural chemicals, as practiced in California, is entirely adequate to secure maximum thoroughness of investigation and safety to the consumer, and yet is consistent with the expediency to be desired in the development of new pesticides for the protection of agricultural crops.

H. T. Armitage, *chief, Bureau of Entomology, State Department of Agriculture, Sacrameno, Calif.:*

In view of present safeguards it seems unnecessary to make further federal legal restrictions and the present method of establishing spray residue should be streamlined.

It is recommended that responsibility for the determination of use of pesticides in the control of insects remain the duty of the United States Department of Agriculture, that responsibility for determination of toxicity to man and



Worker applying a fine mist spray to fruit trees in the Northwest. By such applications of pesticides, farmers have assured larger yields.

animals in connection with the use of pesticides be given to the United States Public Health Service, and that the United States Food and Drug Administration continue as the enforcement agency for spray residue on produce.

C. E. Chase, *Wenatchee, Wash., a layman who said he has had a great deal of experience in the use of insecticides during a period of over 35 years:*

We believe, and strongly urge, that in the future all tolerances set under the procedure authorized in the Food and Drug Act, including administrative and tentative tolerances, be based entirely on the recommendations of the U. S. Public Health Service, as was done in establishing the administrative tolerances on arsenic and lead.

Use Health Service

In addition to their own research, the U. S. Public Health Service, in arriving at tolerances safe for public health, would be the competent authority reviewing the results gained from research, work and studies made by other laboratories, colleges and agencies, and also from whatever authentic information they receive from manufacturers.

The U. S. Public Health Service was one of the first agencies established by our government. Their findings and conclusions are accepted throughout the scientific world.

Enforcement Agency

We believe that the Food and Drug Administration should be an enforcement agency only in enforcing rules and regulations pertaining to insecticide tolerances and their application to fruits and vegetables. The problems of enforcement inevitably subject them to considerations that, in our opinion, should not be permitted to infringe upon research in any way. This, of course, would particularly apply to this agency not making determinations of their own in connection with the toxicity of insecticide residues which result from spraying and other uses in the production of fruits and vegetables.

Another important factor of this question is the determination of necessity for use of insecticides. We believe this should be done by the U. S. Department of Agriculture, as is now authorized by the Federal Insecticide, Fungicide and Rodenticide Act of 1947.

The U. S. Department of Agriculture is an agency vitally concerned with production and consumption. They are vitally concerned with the health of consumers. From the testimony of Dr. Fred C. Bishopp and Dr. E. L. Griffin of the Department of Agriculture, together with that of Dr. George C. Decker of the Illinois Agricultural Experiment Station, and others, it appears to us that but little additional legislation is required to protect the public under this act.

If, in the judgment of this committee, further legislation becomes necessary, it would seem it should be accomplished by an amendment to the Act of 1947.

USDA Does Job

From the testimony of these witnesses, it appears that the Department of Agriculture, in determining the label requirements for insecticides, and whether they shall be released for use, obtains all available known information and evidence in connection with the insecticide they are considering. They call on the Food and Drug Administration, the U. S. Public Health Service, manufacturers, research organizations, both private and public, as well as colleges, and experiment stations which may have knowledge of the particular insecticide being considered. From this evidence, after evaluating it, they make their decision as to the label requirements as well as whether or not they will approve its use.

It would seem that this would be the safest and fairest method in making these determinations, and much better than setting up a very large and fully staffed toxicological laboratory under the Food and Drug Administration to do this work.

In many instances, the testimony before your committee indicates that the witnesses feel that an impartial agency should make the determination of toxicity. In some instances they refer to the Food and Drug Administration as being such an impartial agency.

With all due respect to the Food and Drug Administration, we have found them to have been loathe to change their minds when they have set an informal or tentative tolerance. And characteristic, we think of most enforcement officials, they

do not like to admit mistakes. As mentioned before, this has been very costly to our industry, and thus greatly impaired the welfare of producers.

We believe that if your committee concludes that further funds in the way of appropriations should be made available to the U. S. Public Health Service, as suggested by the administrator, it would be very helpful to the entire program if you will so recommend.

In view of our past experience, and after carefully studying much of the evidence presented to your committee, we respectively propose a program in respect to insecticides used in the production of fruits and vegetables as follows:

1. That the determination of use of insecticides remain the duty of the U. S. Department of Agriculture, and any further authority the committee feels necessary be supplied by amendments to the present Federal Insecticide, Fungicide and Rodenticide Act of 1947.

2. That all determinations of toxicity in connection with the use of insecticides by the fruit and vegetable industry be determined by the U. S. Public Health Service, and all tolerances set under the procedure authorized in the Food and Drug Act, including administrative and tentative tolerances, be based entirely on recommendations by the U. S. Public Health Service.

3. That the Food and Drug Administration be designated as the enforcement agency for which we believe they are well organized and qualified; and that their authority be limited to enforcement of the law.

Industry Approval

We are confident that the fruit and vegetable industry would approve such a program and lend their united support toward its enactment and adoption.

Fred L. Overly, *horticultrist, State College of Washington, Tree Fruit Experiment Station, Wenatchee, Wash:*

The Food and Drug have made every effort to guard the consuming public by checking and placing tolerances on spray residues on fruit for interstate shipments.

It therefore would appear reasonable if additional legislation is needed to develop the following:

1. Give greater support to the research agencies of States and Federal Government in order that they can conduct more complete investigations on the need of the different chemicals and develop combinations for their use so that the grower can get control of his insects and diseases without any toxic effect to plants, man or animals.

Support Health Service

2. Give greater support and permit a wider field of investigation for U. S. Public Health Service to conduct in cooperation with the State and Federal Research agencies, complete studies on the toxicity of all chemicals recommended and necessary to use in control of insects and diseases.

3. Give the Food and Drug Administration power to regulate the use of the materials that are considered harmful and toxic by the two above agencies.

Francis M. Pottenger Jr., M.D. *Monrovia, Calif:*

Any compound possessing substances which may be lethal under any circumstance, or which may lead to chronic illness, should be throughly reported to the consuming public.

Foods that are sprayed during the process of growing, preparation for the market or during the handling for final distribution should contain warnings so that the public is at least made aware of the fact and can choose for himself whether he wishes to take the risk.

Bernard Krohn, M.D. *Monrovia, Calif:*

We should have a Federal statute requiring anyone who uses a pesticide on or near food to prove that his methods do not make the food poisonous for human consumption.

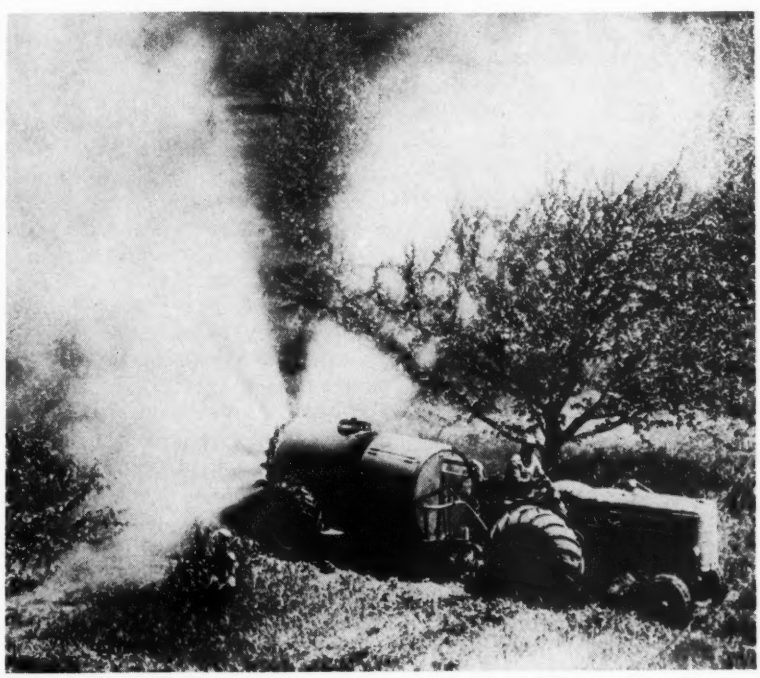
Present laws are inadequate. They charge the Food and Drug Administration with finding the poisoned foods in a tremendous flood of crops, an almost impossible task.

Burden of Proof

Manufacturers, growers, and purveyors of food should be required to prove that they have not added enough pesticide to their products to make them toxic to susceptible people; they should have to do this before being permitted to sell their products.

W. M. Hoskins, *professor of entomology, division of entomology,*

The John Bean Speed Sprayer, pictured below, is a new labor-saving method of applying spray material for insect control in orchards.



agricultural experiment station, College of Agriculture, University of California, Berkeley:

From the point of view of one whose business is pest control, there is little serious harm in slower introduction of new chemicals, for there always have been losses because of pests and there always will be despite every effort to prevent them.

The really serious point is a drying up of the supply, brought about by regulations which make the development of a new chemical too expensive.

It should be noted that agricultural chemicals in general and pesticides in particular, both in the United States and elsewhere, have almost always been introduced by private individuals or organizations who hoped thereby to build up a profitable business. Governmental scientists and technicians have done excellent work in screening compounds for possible usefulness and in testing those which were made in quantity by industry but they contributed next to nothing toward the essential step of making enough material and putting it in proper condition for use. . .

Coordination Needed

The need is not for increased restrictive legislation but for increased coordination of efforts. The numerous committees now looking into the matter of chemicals in food are proof of a lively and healthy interest in this important matter.

If the advice of a disinterested group of distinguished agriculturists, entomologists, food processors, chemists, physicians and toxicologists could be sought by the officials of the USDA regarding the licensing for use of new agricultural chemicals whose hazardous nature is in doubt, the decisions of these harassed officials would be more reliable and unnecessary fears of the public would be allayed. Perhaps the Committee on Foods of the National Research Council can undertake this function.

Statement of the **Bureau of Adult Health, State of California, Department of Public Health:**

There are a number of unanswered questions common to both occupational health and consumer health, which limit the efficacy of our control measures. These include:

1. The problem of residues of agricultural chemicals on farm products.

There still are large question marks as to the length of time which certain chemicals remain active. For example, we have had reports in the past two years of at least two instances in which fruit pickers were overcome, apparently by inhalation and skin absorption of organic phosphorus chemicals, in one case 11 days after application of the chemical and in another case about 30 days following application.

While we are concerned entirely with the occupational hazard involved, one can readily see that there may be a consumer hazard as well.

2. The relatively new problem of some of the so-called "systemic" chemicals such as octomethylphosphoramide (OMPA), which have the ability to penetrate the growing plant and become a part of its structure so that the plant itself becomes poisonous to insects, thus eliminating the necessity of periodic external application of the chemical to the growing crop.

Thus far, registration of these products in California is being held up until further information on toxicity is obtained. As we understand it, these chemicals would be restricted to use only on non-food crops. However, one can appreciate the urgent need for controls to make sure that these materials do not get into food crops.

3. Our knowledge of the chronic disease effects of many of these chemicals, including both old and new ones, is extremely deficient. While we know of many instances of acute poisoning, and these can be documented and described, our knowledge of the possible long-term effects of inhalation or other contact with small amounts of these materials is poor.

Further intensive research is needed, and this means that governmental and private support is needed to make possible this research.

In conclusion, we should like to repeat a statement made before a meeting of the American Chemical Society about two years ago regarding the need for a public health program for the control of economic poisons:

"A well planned public health program is needed for the safe exploitation of the agricultural chemicals. Such a program should embody the following features:

"Research. Many economic poisons are released on the market prior to adequate research in their toxicity.

"Too often human injury is the stimulus to research which should have been done before the material was used. There is need for the training of more personnel in the fields of toxicology, pharmacology and occupational health. There is an urgent need for the augmentation and improvement of present research facilities. There is a need for the better coordination and free exchange of information between private and public research groups.

"Cooperation of Private and Public Agencies. The Federal, State and local public health agencies, the agricultural agencies, and the chemical manufacturers and distributors should maintain a close liaison for the exchange of information and the prompt promulgation of public education and control measures.

"Legal Controls. These include a labeling law requiring all economic poisons to be clearly labeled according to content and amount of each ingredient, with appropriate statements on first aid measures and precautions; and an adequate system of inspection and enforcement for the presence of poisonous residues on the surface of, or within, the foods placed on the market.

Consistent Legislation

"It is recommended also that the states adopt legislation consistent with the Federal laws.

"Education in the occupational health and consumer health aspects must be extended. Public Health agencies in collaboration with the agriculture and food and drug agencies should disseminate appropriate educational material for farmers and allied workers, for the employees engaged in handling and manufacturing economic poisons, for the medical and allied professions, and the public generally." ◆

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Nitric acid used

for production of

Complex Fertilizers

which are easy to use and give good results

By A. Constant
Société Anonyme
des Usines DIOR

Paper presented at technical meetings of the International Superphosphate Manufacturers' Association in Paris Sept. 25 and 27, 1951.

THE world shortage of sulfur poses for superphosphate manufacturers a difficult problem both in regard to the quantity to be produced and the cost.

The solution, which consists of substituting nitric acid either partially or completely for sulfuric acid when attacking phosphates, is interesting from both these points of view because the nitrogen introduced is obtained in the form of nitrate of lime. It is more economical to produce this nitrate on the basis of phosphate than on that of carbonate of lime.

The aim of this article is to indicate the conditions for the transformation of tri-calcium phosphate into mono-calcium phosphate according to the processes worked out by Société Anonyme des Usines Dior to form nitrated superphosphates called "nitrophosphates" or "phospho-nitrates."

Principal Reactions

The principal reactions possible between phosphate rock and nitric acid are as follows:

(1) $Ca_3 (PO_4)\ 2 + 6\ HNO_3$
$2\ H_3PO_4 + 3\ Ca\ (NO_3)2$

(2) $Ca_3 (PO_4)\ 2 + 4\ HNO_3$
$CaH_4\ (PO_4)\ 2 + 2\ CA\ (NO_3)\ 2$

(3) $CACO_3 + 2\ HNO_3$
$CO_2 + Ca\ (NO_3)\ 2 + H_2O$

(4) $Fe_2O_3 + 6\ HNO_3$
$2\ Fe\ (NO_3)_3 + 3\ H_2O$

(5) $Al_2O_3 + 6\ HNO_3$
$2\ Al\ (NO_3)_3 + 3\ H_2O$

(6) $CaF_2 + 2\ HNO_3$
$2\ HF + Ca\ (NO_3)_2$

(7) $2\ CaF_2 + SiO_2 + 4\ HNO_3$
$SiF_4 + 2\ Ca\ (NO_3)_2 + 2\ H_2O$

The last two named occur only at a high temperature and not at 35 or 40° Centigrade.

In the case of solubilization by a mixture of sulfuric and nitric acids or by nitric acid alone, precaution must be taken that this limit of temperature is not exceeded because the only material suitable for for this kind of manufacture, stainless steel with 18 per cent chromium, 8 per cent nickel and 2 per cent molybdenum, is very rapidly corroded by fluorine compounds. This limitation of temperature, in addition, results in a considerable saving of acid.

Vapor Pressures

Another reason for keeping within this limit lies in the consideration of vapor pressures of the acids used which often contain large N_2O_4. Experience has shown that during manufacture losses of nitrogen are maintained at less than 1 per cent if the reaction temperature is less than or equal to 35° C., 40° being a tolerable maximum in certain circumstances.

The first condition to observe is the following: The reaction temperature must be limited to 35–40° (C.) as long as nitric acid remains free.

In ordinary superphosphate the salts formed—mono-calcium phosphate and calcium sulfate—are not hygroscopic. Knowing the loss of moisture during manufacture, it is easy to determine the minimum concentration of sulfuric acid to be used.

It is not the same with phospho-nitrates, the calcium nitrate which can crystallize with four different hydration values: 0–2–3–4. The range of hygroscopicity of the tetra-hydrate varies from 56–36 according to temperature, a figure which is too low for a satisfactory appearance.

Moisture Regulated

The moisture can be readily regulated, because the loss is almost nil during manufacture, and it is easy to determine for each type of phosphate rock the degree of hydration desired and to find out the behavior of the product.

For Morocco phosphate containing 33 per cent P_2O_5, for example, when disregarding the nitrates of iron and aluminum and taking into account the normal hydration of mono-calcium phosphate, the following results are found for the hydration of calcium nitrate according to the concentration of the nitric acid used:

With a 70 per cent concentration, 3.25 molecules of $Ca\ (NO_3)_2$ formed for one of $CaH_4\ (PO_4)_2$, and trihydrate was formed.

With an 80 per cent concentration, no $Ca(NO_3)_2$ was formed and 0.15 molecules of anhydrate and 3.15 molecules of di-hydrate were formed.

With a 90 per cent concentration, no $Ca\ (NO_3)_2$ was formed and 1.95 molecules of anhydrate and 1.3 molecules of dihydrate were formed.

Second Condition

Hence the second condition, borne out by experience for temperate climates:

The concentration of the acids used must be such that the hydration of the calcium nitrate forms

either less than or, at most, equals two molecules of water.

In the case of an attack by sulfuric and nitric acids the concentration of the two acids depends on each other. With concentrated sulfuric acid, for example, the concentration of nitric acid may diminish to 50 or 60 per cent. With nitric acid alone, the concentration is calculated as a function of the above condition.

For a phosphate rich in iron and alumina exides, the degree of hydration of the corresponding nitrates has also to be calculated.

The reserve of dryness thus allowed obviates all the difficulties in connection with bagging, transport and spreading.

Shed Storage

Storage in sheds does not present any difficulty, if some of the heat due to the reactions and, above all, to crystallization escapes only after storage.

As we have seen, the composition of the phosphate governs the concentration of the acid or acids used. There is, therefore, no difficulty if a sufficiently concentrated acid is available.

It is not the same with regard to the maintenance of the reaction temperature at 35° because the volume of liberated heat is considerable.

With superphosphate, the same method could be applied in all climates, but for phospho-nitrates it is advisable to provide for different means of cooling according to the surrounding temperature in the manufacturing plant.

With a surrounding temperature of −30° (C.) the means would be small or nil; they would be considerable with those of +20 or +30.

The process requires the installation of special means of cooling for part of the heat evolved by the actual reactions or crystallizations resulting. It varies practically from 50 to 10 per cent according to the manner of solubilization used in temperate climates.

The remainder of the heat produced is lost by radiation.

This process applies to all methods of solubilization; with nitric acid alone or with sulfuric and nitric acids acting either together or separately.

The whole of the reactions can be divided into three successive phases:

(1.) In the first, all the acid is introduced and approximately ⅔ of the phosphate in such a manner as to obtain reactions (1)-(3)-(4)-(5).

The operation is carried out in a trough with cooled walls whose capacity, for the same tonnage to be produced varies according to the climate.

The liquid slurry resulting from previous reactions between the same constituents revolves in this trough. The phosphate and the acid or acids are introduced continuously at certain selected points, a corresponding quantity being withdrawn continuously through an outlet which is as far as possible from the points where the raw materials enter. Agitators prevent the slurry from frothing because of the liberation of CO_2.

(2.) The product leaving the outlet is composed mainly of free phosphoric acid, non-hydrated calcium of lime, sulfate of ammonia—if sulfuric acid is employed—and of the gangue of phosphate which readily remains in suspension.

To this is added, in a second trough, the remainder of the phosphate. The whole undergoes a brief mixing with a continuous motion toward the outlet where the material is in an almost solidified state.

(3.) In order to break up the mass leaving the second trough, the natural tendency of phospho-nitrate to granulate is utilized in a long trough equipped with paddles, producing an energetic mixing and a slight movement toward the outlet.

Cold Product

Crystallization is accelerated by adding a previously finished cold product which has been reduced to the fineness required.

The granules formed then are passed over two superimposed vibrating screens. The oversize granules are re-crushed and re-cycled with the fines into the granulator.

The medium-sized granules constituting the marketable material are sent to the store. They harden very rapidly. The three apparatus are arranged one above the other so that the flow from one to another is effected by gravity. From the entry to the outlet of the apparatus duration of flow is approximately one hour.

With this method, only the trough of the first phase need be cooled up to the outlet where the acid or acids of the attack are neutralized.

The engendered heat is completely or partially counteracted by the heating of the raw materials introduced and for the remainder, by the circulation of water or the sprinkling of water around the walls.

It is possible also to cool the acid. As indicated, the required amount of cooling can be calculated readily in each case. In hot weather it is advisable to cool the finished product before re-cycling it in the circuit.

This article is concerned especially with the mutual action of nitric and sulfuric acids. This is interesting because of the products obtained and because it requires less concentrated nitric acid when 78 per cent or stronger sulfuric acid is used.

Two Phases

Two cases present themselves:

(1) The two acids are mixed before use:

The reactions are extremely marked and precautions have to be taken to avoid the generation of nitrous vapors because of the rise in temperature.

So long as the sulfuric acid remains free, it decomposes the calcium nitrate giving rise to regenerated nitric acid and calcium sulfate. But the latter does not adhere to the phosphate grains as in the case of the manufacture of superphosphate. This enables the reaction to carry on actively until the attack is completed.

(2) The two acids react separately:

If the manufacturer has at his disposal the two acids separately in an existing superphosphate unit, it is of particular interest to treat the phosphate in two phases instead of attacking it with a mixture of sulfuric and nitric acids.

First, the sulfuric acid acts upon a portion or the entire phosphate and the intermediary product thus obtained is then treated with nitric acid. This product may also be ordinary superphosphate coming from storage; in that case the apparatus described above are sufficient. The superphosphate and one por-

tion of the phosphate are introduced into the first trough, the other operations following the same conditions as in purely nitric solubilization.

The P_2O_5 of the mono-calcium phosphate is transformed into free phosphoric acid and enters again in its original state into the succeeding operations. This reaction evolves very little heat.

The apparatus must be completed by a continuous mixer and a cooling tube if the attack by sulfuric acid is carried out in the plant. When treating the greater portion of the phosphate, the reaction is less pronounced, especially if the acid is cooled. Fluorine compounds are not liberated, hence the considerable saving in sulfur.

The apparatus is common to all types of attacks described above.

The trough for the first phase as well as the agitators is of stainless steel of 18 per cent Chromium, 8 per cent Nickel and 2 per cent Molybdenum.

It takes the usual form of two rectangles bracketed together along one of the long sides with a communication at each of their ends. A double jacket is used for cooling.

Second Phase

The second phase takes place in a trough of the same metal of a semicylindrical shape along the axis of which is fitted an agitator with paddles. They produce a radial and axial movement so that the products circulate upwards and downwards. This trough is not cooled.

The third phase takes place in a third trough of ordinary sheet steel of the mixer type with two parallel shafts with paddles producing a radial and axial motion, as in the case of the trough described in the second phase.

An energetic mixing is necessary in order to mix thoroughly the upstream end where the recycled finished product is added to the product leaving the second trough.

The three troughs are arranged one above the other so that from the inlet to the outlet the materials circulate by gravity. The remainder of the apparatus, distribution screening and manipulation are similar to those installed in all fertilizer works.

With the methods indicated it is possible to obtain quite a range of products.

The nitrogen and P_2O_5 content depend upon the content of the phosphate in the materials used for this reaction.

With a 33 per cent Morocco phosphate and with a rate of attack of 90.95 per cent, it is possible to obtain, by varying the proportions of sulfuric and nitric acids, quite a range of products where the ratio P_2O_5 varies practically from 2 to 4:

Range of Products

Nitric nitrogen 8 per cent water-soluble P_2O_5 15.5 per cent citrate-soluble 0.5 per cent or

Nitric nitrogen 4 per cent water-soluble 15.5 per cent citrate-soluble 0.5 per cent.

By suppressing sulfuric acid, which can be effected in the manufacturing process mentioned in the first place, an 8–16 fertilizer is obtained. It should be noted that the production of the apparatus is twice as large as in the case of fertilizer 4–16 which is obtained by solubilization with half the quantity of sulfuric acid, the other as nitric acid, by seperate action of the two acids.

The storage in sheds is satisfactory and can be continued for a long time because the presense of both sulfate of lime and calcium nitrate is very advantageous.

Following are compound fertilizers on the basis of phospho-nitrate:

(a) Binaries with nitrogen partly in a nitric and partly in an ammoniacal form are obtained by the addition of sulfate or phosphate of ammonia.

Nitrate of ammonia is not suitable because it forms, with the nitrate of lime, a double salt 1 NH_4NO_3 $-5Ca(NO_3)_2$ $-10H_2O$ which is extremely hygroscopic.

(b) Ternaries.

Calcium nitrate does not mix well with chlorated compounds, but very well with phosphate, sulfate and nitrate of potash. The mixture $2NH_4,NO_3$ 1 K_2SO_4 undergoes a double decomposition to form 2 KNO_3 $-1(NH_4)_2SO_4$ which also gives good results.

Similarly, it is possible to use bi-sulfate of ammonia and potash which are more easily produced than the corresponding neutral chemicals by themselves.

Certain processes which do not fall within the framework of this study permit the economic production of ternaries very rich in fertilizer elements in which the P_2O_5 is almost entirely water-soluble.

In the production of all these compound fertilizers the apparatus described above are used. As in the case with phospho-nitrates, these fertilizers are obtained in granulated form without drying.

It appears to be well demonstrated that the nitrate of lime contained in the phospho-nitrates or their derivatives disappears less quickly from the soil than when spread by itself. This results in a saving of nitrogen and a better action on the plants. These effects are still more noticable with products of sulfuric-nitric solubilization.

Applied in equal quantities, the compound fertilizers based on phospho-nitrates have an action superior to their homologues produced with ordinary superphosphate.

The reason for this lies probably in the fact of the intimate association between the two or three salts: nitrate, phosphate and calcium sulfate.

The phospho-nitrates based on a nitric solubilization alone are recommended as spring fertilizers. The others can be applied more or less on the same conditions as superphosphate.

Conclusions

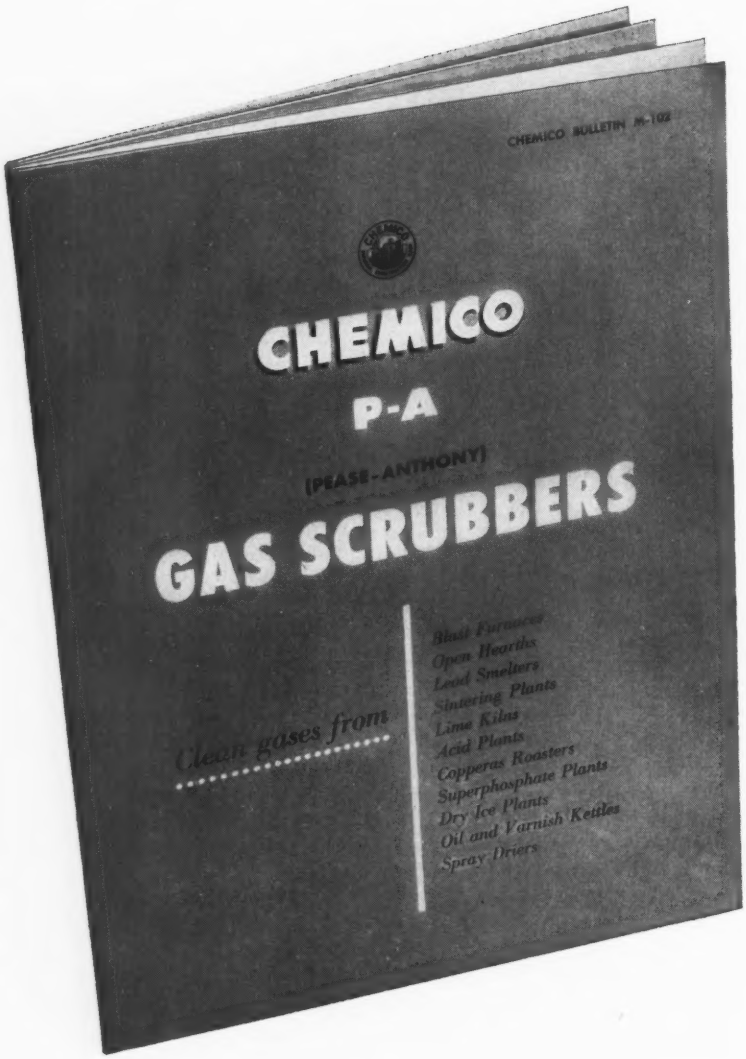
(1.) It is possible to manufacture economically fertilizers on the basis of water-soluble phosphoric acid by substituting nitric acid for sulfuric acid either completely or partially and to counteract the lack of sulfur.

(2.) The products obtained by this substitution are very suitable for the manufacture of compound or complex fertilizers.

(3.) All these products give excellent results when applied to crops, owing probably to the presence of calcium nitrate, the apparent solubility of which is diminished by the fact that it is coated or intimately mixed with the other constituents.

(4.) Because of the precautions mentioned above, the fertilizers reveal a better behavior than the extent of their hygroscopicity in the laboratory would indicate and can be stored, distributed and spread without special precaution other than the use of bags which are water-proof. ◆

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Application of

Chemical Fertilizer

with good crop rotation system gives a sound, steady economy

By Jackson B. Hester

Soil Technologist
Campbell Soup Company

THE rotation of crops for various reasons has been practiced in some countries since biblical times. During earlier times it was practiced to maintain a more stable nutritional balance for those crops which brought the highest cash value. In the Carolinas in the early nineteen hundreds cotton was the prime cash crop. Consequently, the crop rotation system was designed to make available sufficient plant nutrients to produce profitable crops.

This rotation system consisted primarily of cotton followed by grain, interplanted with legumes or followed by legumes, and either corn or cotton in the final year. The only commercial fertilizer used was approximately 75 pounds of superphosphate per acre underneath the row with all of the available manure.

Following these times and particularly during depression years slightly more fertilizer was used but the rotation system broke down into the planting of continuous cash crops which resulted in big losses from wind and water erosion and leaching.

In some southern states zinc deficiency (or white bud in corn) was common. Many growers found that if a common weed, purslane, were grown and turned into the ground prior to planting corn white bud would not occur. Apparently this common weed had the power to extract enough zinc to offset the deficiency in corn.

With scientific improvements many of the deficiencies in crops have been recognized, described and corrected by the proper application of certain nutrients. With the demand for tremendous volumes of food and feedstuff the prices of these products have advanced to the point that a great fertilizer industry has developed.

With the advent of soil analysis and available fertilizer materials it becomes necessary to re-examine the crop rotation system from the standpoint of proper application of fertilizer materials and liming practices.

Rotation System

The crop rotation system should be designed and planned around the economics of the crops to be considered and the soil types involved. The factors that should be considered may be enumerated as follows:

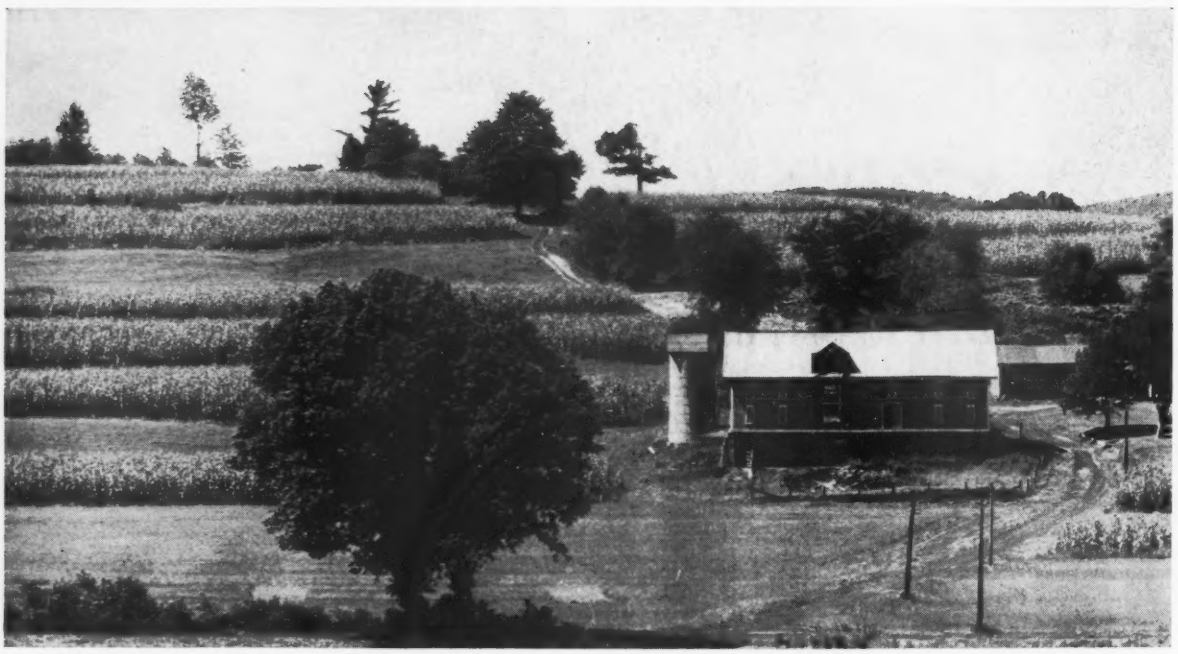
1. Soil erosion (wind and water).
2. Soil aeration and drainage (deep rooted crops).
3. Maintaining or increasing organic matter (to create granulation favorable for root crops).
4. Increasing nitrogen supply through legumes.
5. Minimizing diseases and insects in plant culture.
6. Minimizing or eliminating secondary and trace element deficiencies.
7. Keeping a crop growing on the soil at all times.
8. Minimizing or eliminating leaching and fixation of plant nutrients.
9. Stimulating microbiological activity.

Effect of Erosion

It is not necessary to emphasize further the tremendous toll that both water and wind erosion have had upon the agricultural possibilities of the United States. Because of these factors strip cropping, terracing, etc. should be planned so as to minimize erosion. On flat ground the strips may be broader, but they are needed to help break up the movement of wind currents and surface water.

Many soils are compact and tend to become increasingly so with continuous removal of cash and shallow rooted crops such as spinach and parsley. The intermixture in the rotation of crops with deep root systems and those which add large quantities of crop debris, creates better aeration and drainage in the soil. This condition makes the expensive cash crops grow more abundantly and luxuriantly.

The value of having adequate organic matter in the soil has been recognized for ages. The most troublesome features in increasing organic matter in the soil are the time required and method of distribution. Under certain conditions more organic matter can be grown and returned to the soil through the use of cash crops and fertilizer than can be distributed over the field if the available manure is free. For example, the use of corn stalks from heavy plantings and the



This photograph shows a well-organized farm with a carefully planned use of strip cropping. Strip cropping helps assure a stable production of various crops and is a big aid in preventing erosion by wind and water.

straw from grain and inter-seeded legumes might provide organic matter cheaper than the distribution of manure.

Nitrogen Supply

Legumes, such as certain of the clovers, lespedeza, and others, seeded in the grain and allowed to grow through the summer fix substantial quantities of nitrogen from the atmosphere.

Certain diseases such as root knot on rutabaga turnips, club root, nematodes and insects (wire worms) build up in the soil when crops follow each other which are extremely subject to these diseases and insects. The crop rotation system should be designed to plant crops following certain of these crops which do not perpetuate the diseases or build up large populations of insects.

If nematodes exist in the field and have destroyed a particular crop, the following crop should be that which tends to starve out or minimize the activity of nematodes. A similar analogy may be drawn about club root in rutabagas and other root and tuber diseases.

Secondary and trace element deficiencies have become an increasing problem, particularly on the lighter eastern seaboard soils.

Magnesium is a secondary element which has attracted considerable research work and attention. Magnesium deficiency has been observed in tomatoes and other crops where a ton of finely ground dolomitic limestone was used. Magnesium is held very strongly by the clay material in the soil. Under certain rainfall conditions and through leaching, magnesium deficiency frequently is a disturbing factor in crop production.

A crop rotation in which fresh organic matter, carrying magnesium, is decomposing steadily in the soil offsets this condition. The same is true with the trace elements. Boron leaches from the soil readily. The instance of zinc deficiency has already been described. To have these elements associated with the decomposing organic matter of the soil is practically a guarantee that these deficiencies will not be disturbing factors in plant growth.

Continuous Cropping

In the humid region, soils in the natural state possess vegetative growth virtually all year. In most sections it is possible to have some plant growing in the soil almost all year. These plants increase organic matter content and the life of the soil.

Water moves through the soil and establishes the water table found at various levels in the soil. This water carries with it soluble ions. Leaching of the soil can be either good or bad. It is good if it carries away those elements not needed by the plant or animal which may be toxic to both. It is bad if it removes those nutrients needed by both plant and animal.

Some Leaching

It must be recognized that there is bound to be some leaching of plant nutrients. This can be serious in sandy soils where plants are not growing. Therefore, leaching of plant nutrients from the soil can be prevented by having them absorbed by a growing plant. The crop rotation system should be sound and interplanted with winter protective cover crops and summer catch crops.

The application of large volumes of organic matter of various sources increases the microbiological activity in the soil. There is available the residue from the corn crop which is very high in lignin and carbohydrates. This is different from the leguminous debris and the highly fertilized tomato plant. The organic matter from the decomposing tomato vines actually amounts to a very high nitrogen

(Continued on page 49)



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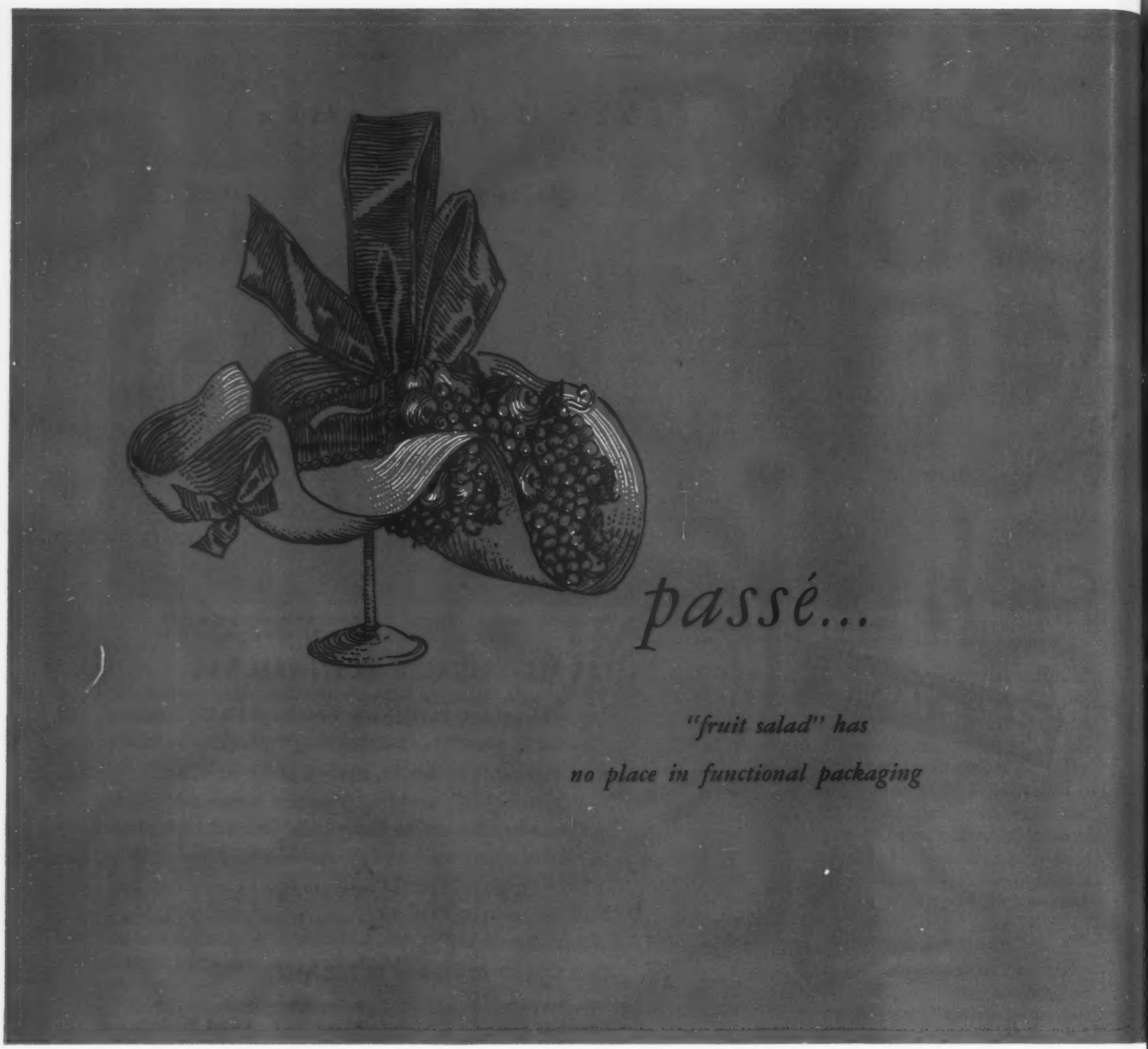
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FERTILIZER MATERIALS MARKET

New York

February 11, 1952

Sulfate of Ammonia

Shipments are going forward against contracts and demand continues good from various sections with no further price changes noted since the material was advanced slightly in price on the West Coast.

Nitrate of Soda

Importers claim they have been able to supply all the normal demand for this material and material is moved out as fast as arrivals of ships are made.

Ammonium Nitrate

Demand continues heavy for this material but the new Morgantown, West Virginia, plant should be in operation in March which might help relieve the situation.

Nitrogenous Tankage

With various producers sold ahead for some time and with imported material hard to obtain for nearby shipment, the supply situation is tight at the moment. Very little relief is looked for the balance of this season.

Castor Pomace

No offerings have been made recently by the producers because of the current small production and the price remains unchanged at $37.25 per ton, f.o.b. shipping points, for material guaranteed 6.75 per cent ammonia.

Organics

Organic fertilizer materials in general were very hard to buy at the present time due to scarcity of available offerings. Soybean meal was unobtainable at the ceiling price of $74.00 per ton, f.o.b. Decatur, Ill. in bulk, except on some processing arrangement by which the buyer buys the soybeans and pays to have them crushed. Linseed meal also was unobtainable with several large plants closed down. The oil business has been very poor recently and it does not pay the producers just to crush flaxseed for the sale of the meal. Cottonseed meal was not being offered by leading mills. Tankage last sale at $9.00 per unit of ammonia ($10.94 per unit N), f.o.b. eastern points and was well sold up. Blood was in the same position at the same price.

Fish Meal

Imported fish meal continued to arrive at various Atlantic ports and was being sold at about $2.26 per unit of protein, plus certain charges which are allowed by the O.P.S. Some menhaden fish meal is being traded in from time to time on a limited basis. Demand continues good from the feed trade.

Bone Meal

This material is in very heavy demand from the feed trade and sales have been made as high as $95.00 per ton, f.o.b. shipping points, with very little material available. Raw bone meal is offered around $75.00 per ton but offerings are hard to locate.

Hoof Meal

No price changes were noted with last sales on the basis of $7.50 per unit of ammonia ($9.12 per unit N), f.o.b. western shipping points.

Superphosphate

In some sections a slight easing in the sulfuric acid situation was noted which it was thought might help the superphosphate situation, but the over-all picture was still one of tightness and this situation will probably continue for the balance of the shipping season.

Potash

Foreign material continues to arrive at various ports and one new American producer was now reported to have started shipments from Carlsbad. Some buyers considered the market slightly easier as far as supplies were concerned but a heavy demand is looked for in March and April.

Charleston

February 11, 1952

Movement of fertilizers in the Southeast is somewhat behind schedule at the moment. Superphosphate continues exceedingly short of expected demand. Supplies of nitrogen and potash are fairly well in balance with demand.

Organics.—Market on organics for fertilizer use is rather quiet, with domestic nitrogenous tankage nominally at $4.25 to $4.90 per unit of ammonia ($5.16 to $5.95 per unit N), bulk, f.o.b. production point. Imported nitrogenous offerings are scarce with the market nominally $6.15 to $6.25 per unit of ammonia ($7.47 to $7.59 per unit N), in bags, c.i.f. Atlantic port. Hoof and horn meal is available from foreign sources at around $7.25 per unit of ammonia ($8.82 per unit N), c.i.f. Atlantic coast for March shipment.

Castor Pomace.—Production of domestic castor pomace continues very limited and the price at $37.25 per ton in burlap bags, f.o.b. Northeastern production point. $2.00 per ton allowance is made if shipment is in paper bags. Material is guaranteed minimum 6.75 per cent ammonia. Movement is primarily against existing contracts.

Dried Blood.—The Chicago market for unground dried blood is approximately $9.25 to $9.50 per unit of ammonia ($11.24 to $11.55 per unit N), bulk, f.o.b. Chicago area. The New York market is quiet at around $9.00 ($10.94 per unit N).

Potash.—Movement against contracts from domestic sources is in seasonal dimensions. Production continues steady. It is expected there will be no spot period this year. Production this season is expected to be approximately five per cent greater than last season.

Ground Cotton Bur Ash.—This form of potash, primarily carbonate of potash, is available in good

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quantity for prompt and future shipment. Best productions continue to test approximately 40 per cent K_2O and delivers at prices comparing favorably with sulfate of potash.

Phosphate Rock.—Movement of rock to acidulators is heavy, limited only by the amount of sulfuric acid available. Supply position at the mines is comfortable and prices remain firm.

Superphosphate.—Production continues at maximum levels limited only by the supply of sulfuric acid. Market is tight with no easement expected for many months. Production for season 1951–52 is about 6 per cent less than for the season 1950–51.

Sulfate of Ammonia.—Production is threatened by possible strike in the steel mills and movement of supplies directly from production prevents accumulation of stocks at the mills. No change in prices has been announced and the price structure is firm.

Ammonium Nitrate.—Canadian material now is priced at $72.50 per ton, f.o.b. production point and domestic material varies in price from $63.00 to $64.00 per ton, f.o.b. works. Market is extremely tight.

Nitrate of Soda.—Demand is seasonally expanding but supplies are comfortable. Price is currently $57.00, bagged, untagged, at the ports for imported material, and $51.00 bagged, untagged, for domestic material, f.o.b. Hopewell, Virginia.

Philadelphia

February 11, 1952

There is slightly better movement in raw materials, but complete mixtures are not being taken out sufficiently fast. Blood, tankage and bone meal are stronger, and nitrate of ammonia and cyanamid have advanced in price. Superphosphate is in exceedingly tight supply, but there seems to be ample potash.

Sulfate of Ammonia.—The demand from mixers has increased and while supply is reported tight, the scarcity does not seem to be critical. Resales are not much in evidence.

Nitrate of Soda.—There is sufficient of this to meet all requirements, and movement against contracts is increasing. No recent price changes are reported.

Blood, Tankage, Bone.—Blood and tankage are much stronger at $9.00 to $9.50 per unit of ammonia ($10.94 to $11.55 per unit N). Bone also is higher at $85.00 per ton for steamed grade, and $75.00 for raw. Hoof meal is rather neglected and quoted at $7.25 per unit of ammonia ($8.82 per unit N), Chicago basis.

Castor Pomace.—A limited tonnage appeared on the market at $37.25 per ton. This sold quickly and at present nothing is offered.

Fish Scrap.—There are no offerings of domestic production, and the imported meal is quoted at the ceiling price of $135.60 per ton for 60 per cent—equivalent to $2.26 per unit of protein.

Phosphate Rock.—Deliveries are now being ordered out by the acidulators and movement is keeping up with schedule.

Superphosphate.—Both normal and triple grades are in tight supply position with greatly increased demand for deliveries on contracts. Efforts of buyers to increase contract commitments have been fruitless.

Potash.—Domestic production is at capacity and all sold ahead. Deliveries are reported on schedule. There is apparently no great interest in foreign potash at present.

Nitrate of Ammonia. Demand is active and supply very tight. Eastern Canada price has just advanced $3.00 per ton—to $72.50 in Canada.

Cyanamid.—Supply exceedingly limited, and price advanced to $3.40 per unit of nitrogen on pulverized grade, and $72.00 per ton for granular.

Industrial News

New Products *New Plants* *New Appointments*

Pennsalt Vice President Is Named to OPS Position

A vice president of Pennsalt, William P. Drake, has been named director of the Rubber, Chemicals and Drugs Division of the Office of Price Stabilization, OPS Director Michael V. DiSalle announced this month.

Drake succeeds Thomas H. McCormack, who is returning to his duties as director of sales of Grasselli Chemicals Division of DuPont.

Drake will serve as director until July 1, DiSalle said.

As Pennsalt vice president in charge of sales, Drake headed the chemical company's nine sales departments.

He joined the company in 1934 in its student training course.

He was successively a salesman, a manager of sales and assistant vice president in charge of sales, before his appointment as vice president in 1949.

He is a member of the Manufacturing Chemists' Association,



William P. Drake

the American Electroplaters Society and the Armed Forces Chemical Association. Drake is a director of the Main Belting Co., Philadelphia.

'Nitro-Mulch' Used in West To Fight Drought Conditions

Distribution of "Nitro-Mulch" by the Fortified Farm Products Co., Portland, Ore., has begun in the Washington, Oregon, California area. The new product is being sold for use on lawns in helping to combat unfavorable drought conditions.

Nitro-Mulch is a mixture of fertilizer materials, vermiculite and compressed peat moss. The vermiculite and peat moss give it a very high water retention capacity and the company claims that treated lawns require only two hours watering even in severe drought.

Fertilizer materials included in the mixture are ammoniacal nitrogen, three per cent; soluble phosphoric acid (from superphosphate), six per cent and water soluble potash (from muriate and sulfate of potash), six per cent.

The material is being marketed in 25-pound bags at $2.98 and in 50-pound bags at $5.95. One 25-pound bag contains enough Nitro-Mulch to treat 1,000 sq. ft. of lawn area.

New Potash Plant

Completion of the New Mexico potash plant of Duval Sulfur and Potash Co. is expected early in March. Work is proceeding on schedule and equipment installations are now being tested.

The plant will be capable of processing 2,000 tons of potash ore per day.

U. N. Will Review Pesticide Supply

The Economic and Social Council of the United Nations is meeting in Geneva, Switzerland this month to review the world supply and demand for insecticides. Special attention will be placed on materials of the chlorinated hydrocarbon groups.

Earl R. Beckner, chief of the chemical and semi-manufactured branch of the manufactured products staff, Department of State, will be the United States representative at the meeting. The head of the chemical division Office of International Trade, Louis N. Markwood, will advise Beckner.

Results of the conference are expected to be of importance because of the heavy demand for DDT and BHC in health programs being carried out throughout the world. Delegates will discuss principally the availability of insecticides, requirements of various countries and shipment and distribution problems.

Tax Tag Sales Drop

Tax tag sales during December, 1951 dropped below those of the same month in 1950. Reports from 13 states indicate sales of 522,228 tons of fertilizer compared with 717,253 during December, 1950, a decrease of 195,025 tons.

Sales and reports of shipments for the first 11 months of 1951 were 6.5 per cent higher than those of the corresponding 1950 period, amounting to 9.9 million tons.

Fertilizer Plant for Oklahoma

Construction of a 20,000-ton fertilizer plant in Oklahoma City is scheduled to begin soon. The $235,000 Oklahoma Fertilizer Co., factory is scheduled for production by autumn.

Ammonium nitrate, ammonium sulfate and superphosphates will be produced in the new plant.


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Industrial News

Activated Fertilizer Building New Plant

Activated Fertilizer corporation has broken ground for a $100,000 plant near Spokane, Wash. S. E. Salter is president of the new firm. Salter said the plant will be producing superphosphate fertilizer by July 1. Plans call for annual production of 120,000 tons.

The plant will be the first of its kind in the area.

Ten officials of the concern helped break ground for the $50,000 structure. Another $50,000 will go into equipment. Total space available will be 4,225 square feet.

As the plant expands to meet the needs of Washington state, more units will be added and triple phosphate will be produced.

Soil men and agronomists of the Washington State College at Pullman and the University of Washington at Seattle are aiding company officials to select equipment and materials.

Clifford Berg, sales manager, states that three carloads of phosphate rock can be stored in a 45-foot steel tower. The rock comes in from Montana, Wyoming and southern Idaho.

Berg said it will take only eight hours from the time phosphate rock comes in until the processed fertilizer is in bags after the plant goes into operation.

New Chemical for Brown Patch

Control of brown patch in lawns can be obtained through the use of "calocure" according to Mallincrodt Chemical Works, manufacturers of the new turf fungicide.

Developed in cooperation with the Rhode Island Agricultural Experiment Station, it is designed for application at any time of the year. It can be applied as a spray or broadcast as a dry mixture using sand as a base.

Control of snow mold may also be obtained and, where this is a problem, the second method of application is preferable. Calocure is a formulation of mercury chlorides with materials that increase their fungicidal value.

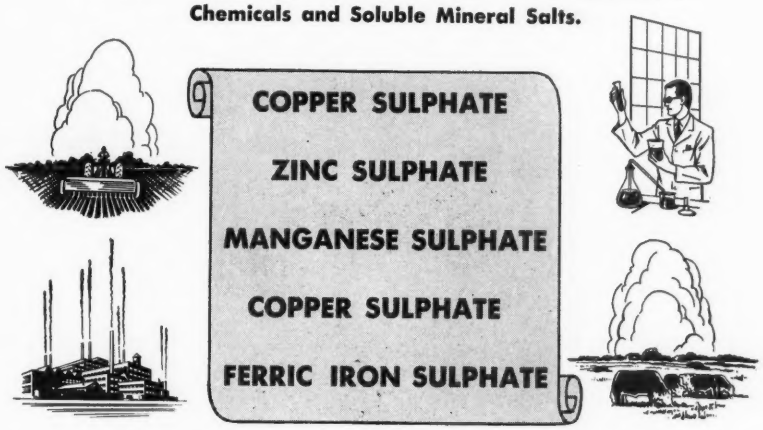
Sulfur Production Goal

The Defense Production Administration has announced that the goal for production of sulfur and sulfur equivalents for 1955 has been set at 8,400,000 long tons.

This represents an increase of 2,230,000 tons over the 1950 supply and nearly 1,250,000 tons over the amount that would be available in 1955 on the basis of existing facilities and the present government stimulization program.



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Industrial News

More Fertilizer Needed in 1955

According to a preliminary report from the State Productive Capacity Committees, American agriculture must use 70 per cent more fertilizer in 1955 than was used in 1950 if the desired level and pattern of production is to be obtained.

Overall requirements for the country indicate that 93 per cent more nitrogen, 54 per cent more phosphoric acid, and 77 per cent more potash will be needed in 1955. This will amount to 1,977,291 tons of nitrogen; 3,220,831 tons phosphoric acid, and 1,916,142 tons of potash.

Regions requiring the greatest increase in nitrogen include the Corn Belt, Lake States, Southern Plains and the Northern Plains.

The Lake States, Appalachian, Mississippi Delta, Northern Plains and Mountain areas show the most need for phosphoric acid and the Corn Belt, Lake States, Mississippi Delta, Southern Plains and Northern Plains areas should receive the highest increase in potash applications, according to the report.

Victor Chemical Plant Starts Big Production

Victor Chemical plant, at Silver Bow, Mont., started production recently with the throwing of an electric switch to open all facilities of the huge furnace and other structures built at a cost of $5,000,000.

Construction was started in August, 1950.

An additional furnace and buildings will be added later to bring plant valuation to about $10,000,000.

Pure elemental phosphorus from the Silver Bow area, a historic mining site, has been the basis for the launching of a huge new industry for the State.

Other Montana sources of phosphorus also are being tapped for stockpiling at the Victor plant.

U. S. Sulfur Exports to Be Reduced By 25,000 Tons From 1951 Quota

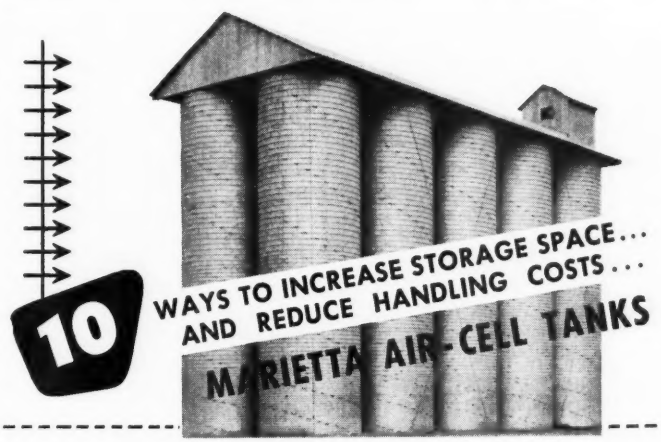
Sulfur exports from the United States for the first half of 1952 will be cut 25,000 tons from the combined quota for the last two quarters of 1951. The Office of International Trade reports that American exports for this period have been set at 465,000 tons of crude sulfur.

So that the quotas will correspond with allocations announced by the International Material Conference, exports are being calculated for the first time on a six-month basis. An IMC report, issued in January, set the amount of sulfur distributed to free Western nations for a six-month period.

OIT says that extending the quota should provide a better allowance for heavy seasonal consumption in some areas and also will aid in facilitating advance booking of shipping space.

Increasing defense requirements were cited as the reason for the cut in crude sulfur exports. However an export quota of 15,000 tons of crushed, ground, refined, sublimed and flower sulfur is equal to that of the last two quarters of 1951.

The two quotas represent about 17.5 per cent of the current estimated U. S. sulfur production rate. Although slightly less than that set aside during the previous period, the decrease will be offset by the increased use, in foreign countries, of sources other than the crude material.



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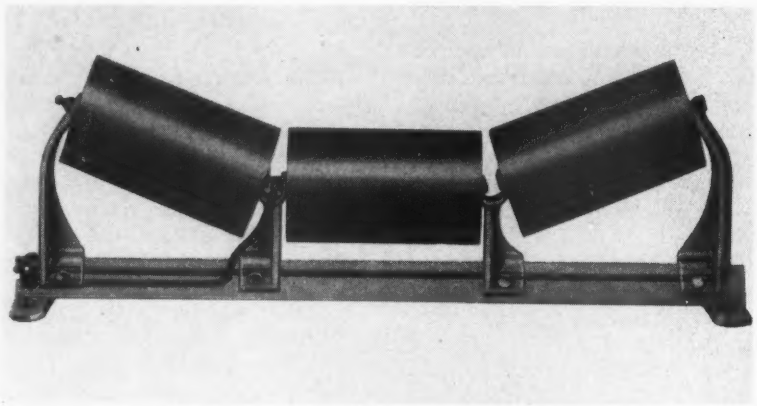
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Industrial News

2-1 New Conveyor Idler



New idler with flexible type grease turbine

Rigid steel grease tubing has been replaced in the new Chain Belt conveyor idlers by reinforced flexible automotive type grease tubing. The tubing will take higher gun pressures and, according to the manufacturer, is not so easily broken off in shipment.

Grease fittings have also been relocated in the new line, permitting easier accessibility and allowing safe servicing at any time. They are protected in shipment by the idler base.

The flexible sections are made in lengths to allow them to "hug" the inside of the channel base or inverted angle. Extension of the tube to the far side is accomplished by threading a flexible section through the base to the grease fitting at the near side.

Chain Belt claims that this new design eliminates the headaches of broken grease lines. For further information use **Readers Service Card 2-1.**

Production of 1,760,000 Tons Of Chilean Nitrate Forecast

An estimated production of 1,760,000 tons of Chilean nitrates during 1951–52 has been forecast by the Nitrate & Iodine Sales Corp. In making shipping contracts for this period, the company said that sales might increase 100,000 tons over the previous period.

Production at the Maria Elena nitrate deposits in Chile, declined during 1951 despite an expansion in the solar evaporation process units. The ponds averaged only 2,000 metric tons monthly during April-August, although they produced 5,635 tons in March.

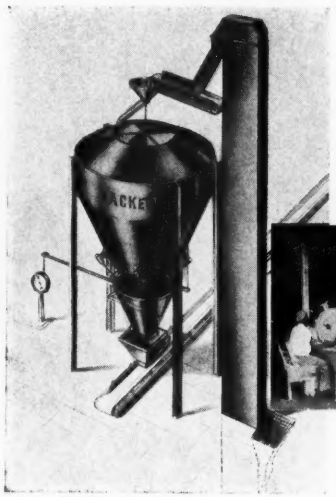
Cia Salitera Tarapaca y Antofagasta, another nitrate development, is reported to be conducting surveys on the proposed mechanization of Iquigue port facilities. The independent Iris plant, closed since March, 1950, opened last August with an initial production of 985 tons.

During the first nine months of 1951, production by the Guggenheim process, Anglo-Lautaro Nitrate Co., showed an increase over that of the corresponding 1950 period. Production by the Shanks method, Cia Salitera Tarapaca y Antofagasta and independent producers declined somewhat.

Mexican Sulfur Up

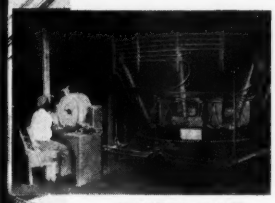
Production of sulfur in Mexico is expected to double within the next two years according to the Government Oil Co. Present production of 40,000 tons will be augmented principally by new recovery plants in Mexican refineries.

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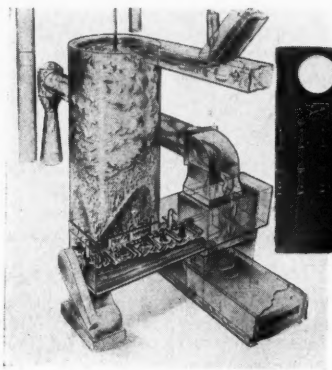
3. Circular design of storage hopper accelerates flow of ingredients through weigh valves . . . no corners or valley angles to retard flow of material.

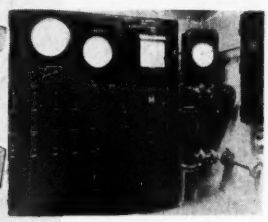
4. Its compact design permits installation in existing buildings with minimum alterations.

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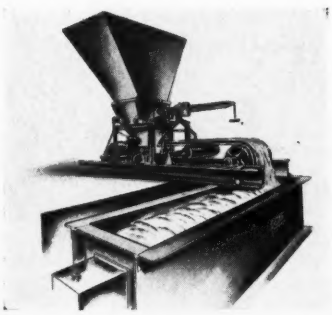
CONTROL PANEL
Central control panel shown above is nerve center of Super-Flo Process. Plant is operated from this point by one man.

This new Sackett-conceived and developed process produces a superphosphate of premium quality in either powdered or granular form. Its complete mechanization and centralized panel control brings to the industry entirely new conceptions of high production speeds, low manufacturing costs and quality product control.

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Exclusive suspended acidulation produces highly converted superphosphate of excellent quality.

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The patented Sackett Continuous Ammoniation System is now being offered in four sizes with capacities ranging from 25 tons per hour to 100 tons per hour. This highly efficient method of ammoniating superphosphates and mixed goods with solutions offers many important advantages and is easily installed in connection with existing basing equipment. Higher ammoniation rates are made possible by its accurate proportioning of solids and solutions and lower reactive temperatures due to its exclusive aerating action which takes place during ammoniation. This system is also built in pressurized design for anhydrous ammonia or solutions having high vapor pressures.

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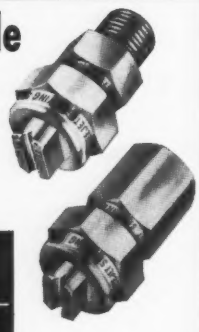
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TeeJet Spray Nozzles are made for use with all types of spraying equipment. Write for Bulletin 58.

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Industrial News

Patrick Retires From Chase Bag

W. L. Patrick, Chase Bag company sales representative for the past 33 years, has retired from his job at the Chase general sales office in Chicago.

Patrick joined the 105-year-old



W. L. Patrick

firm immediately following his service as an Infantry Regimental Sergeant Major in World War I.

Since 1939, his headquarters had been in Boise, Idaho.

Patrick's successor is R. F. Rhoden, a Chase representative since 1947, who has worked with Patrick for the past year.

Rhoden's headquarters will remain in Boise.

2-2 Speed Reducer

Instant and positive protection for driven machines, motors and the speed reducer itself is provided by an overload release for the Dodge Torque-Arm Speed Reducer.

The new product is designed to prevent breakdowns, avoid expensive repairs and insure against interruptions of production resulting from excessive load on equipment.

The release operates mechanically and electrically to loosen belts, cut off current or activate a warning bell, siren or light.

Pressure exerted by an excessive load causes a piston to move lengthwise through the unit. This movement loosens the belts and cuts off the current simultaneously. The warning system is hooked up to a micro switch.

The Speed Reducer is calibrated for adjustment to the load conditions of any job. It can be set to act at any desired load up to the reducer's maximum capacity. For further information on the equipment, fill out a **Reader Service Card,** using **2-2.**

DDT Approved for Some Uses in North Carolina

DDT may now be included in fertilizer mixtures offered for sale in North Carolina. It is recommended by the Department of Agriculture for use in areas where "the white fringed beetle is present and only on specific advice of a Federal or State entomologist."

All brands or mixtures containing DDT must be registered with the department and each bag of such fertilizer must bear a $3\frac{1}{8}''$ x $6\frac{1}{4}''$ red tag noting the amount of DDT contained per 100 pounds and other information.

New Farm Chemicals Plant

Farm chemicals will be produced at a new McIntosh, Ala. plant now being planned by Calabama Chemical Co., Huntsville, Ala. Finished products will not be made at the plant, only basic materials used in formulation.

The nearby Mathieson Chemical chlorine-caustic soda plant will provide the raw materials for the Alabama operation. DDT has been produced in the concern's Redstone Arsenal plant at Huntsville since 1947 and the new unit will be in addition to these facilities.

Brazilian Needs

Brazilian agriculture will require about 16,000 tons of farm chemicals for the 1951–52 crop year according to that country's Ministry of Agriculture.

Materials needed include 1,776 tons BHC; 1,290 tons DDT; 50 tons metaldehyde; 200 tons methyl bromide; 3,300 tons copper sulfate, and 8,400 tons of sulfur.

Your partners

•
•
•

are the farm families throughout the nation who buy your products. Many of their production needs are closely related to yours.

Their success in meeting this year's greatly increased food and fiber goals depends to a large extent upon your ability to manufacture and distribute essential supplies of fertilizers and pesticides.

Farm organization leaders, along with their experienced Washington staffs, are constantly presenting factual data on farm operations to key Congressional and Government officials.

Mounting defense production problems clearly show the need for close liaison between leaders in both groups.

It is apparent that you will both make a greater contribution toward a stronger America with a full breadbasket by . . . working together as partners.

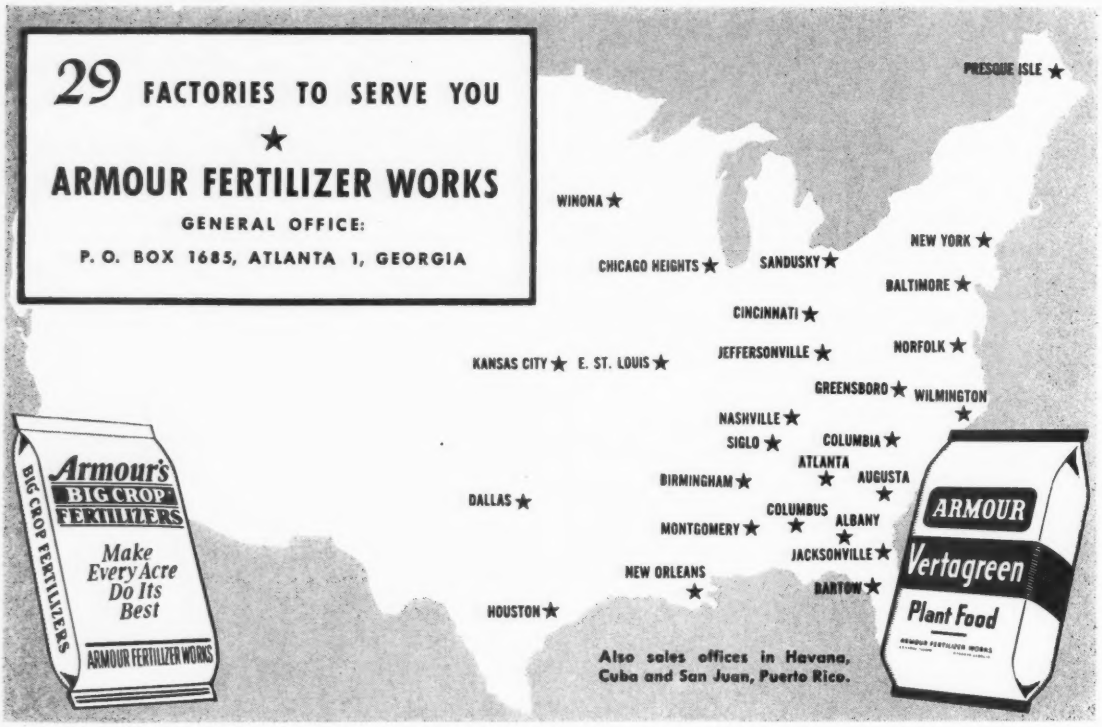
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Industrial News

NPA Reports Insecticide Materials in Good Supply

Members of the Household, Industrial and Dairy Insecticides committee were told by NPA officials at a recent meeting that, with the exception of pyrethrum, most of the ingredients used in the manufacture of insecticides are in good supply. They also pointed out that allethrin, now in plentiful supply, can be substituted for pyrethrum in most cases.

The committee recommended that NPA urge government agencies concerned with the stock piling of pyrethrum to consider the possibility of releasing some government stocks for commercial use. They pointed out that the military is not entirely dependent on the material for many of its uses.

A Munitions Board representative said that there are no plans under consideration for the release of pyrethrum from the government stockpile.

Brass Allocations

Members also requested that NPA increase brass allocations for the manufacture of valves used on aerosol dispensers and that the present limitations on the use of tin containers for insecticides in quantities of less than one gallon be raised from 70 per cent of 1950 use to 90 per cent.

NPA officials advised the committee that tin will remain in short supply. They also urged the use of glass in packing small quantities of insecticides but industry spokesmen said that it is not practical to change to glass containers.

Officials provided the committee with a brief outline of the supply situation of several major insecticide materials. They reported that military requirements for allethrin for aerosol use have not been large enough to limit availability for civilian use. They pointed out that production soon will be augmented by a second plant and that a third will be in operation in 1953 bringing production up to about 500,000 pounds a year.

Chlordane supplies are expected to meet demand and no shortage of lindane was reported. Additional capacity for production of lindane will be added during the year.

DDT Supplies

DDT supplies for 1952 were estimated at 130 million pounds. balancing the requirements of the Department of Agriculture (85 million), military (5 million) and exports (about 40 million).

Production is expected to rise to 155 million pounds in 1955.

Although pyrethrum stocks are low, 1952 imports are expected to equal those of 1951. Department of Agriculture requirements for the year have been set at 5 million pounds.

Rotenone stocks are reported high and 1952 imports will depend on demand. Requirements for the year have been set at 10 million pounds by USDA.

Naco Introduces Plant Food Called 'Nurish' for Retail Sale

Naco Fertilizer Company, New York City, has introduced a new water soluble plant food designed for retail sale. A test mail order campaign for "Nurish", a 20–20–20 soluble fertilizer, began in that area February 10.

The product is being marketed in two sizes of cartons, a one-and-a-half pound package and a three-pound unit. The smaller package contains 32 pre-measured, moisture proof foil packets, each containing sufficient material for making two gallons of plant food, enough for 100 square feet of garden area.

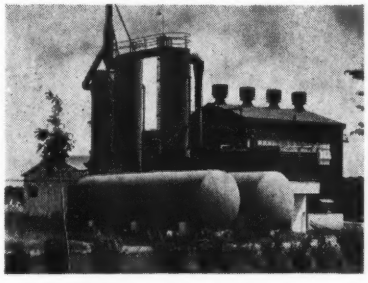
Company officials chose the West Coast area for a testing ground because of the large home garden market existing in Southern California. Naco was aided in the development of "Nurish", by the Battelle Memorial Institute, Columbus, Ohio.

2-3 Safti-Mitt Handpads

Costly hand injuries can be prevented and production can be speeded by using General Scientific Safti-Mitt Handpads, the manufacturer states.

The gloves are designed for maximum protection and comfort. They are adjustable to any size and are provided with a tie string that keeps the pads in place. The gloves are made of leather for long wear.

Time lost because of accidents and infections of worker's hands can be reduced greatly by using the Handpads, according to the company. For further information on the Handpads, fill out a **Reader Service Card,** using **2-3.**



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ATLANTA UTILITY WORKS EAST POINT, GA.

Chemical Fertilizer with Crop Rotation

(*Continued from page 32*)

material which influences the nitrogen-carbon ratio in the soil; that is, lowers it to a more desirable content from an agricultural standpoint.

Rotation Example

Crop rotation systems with tomatoes have been under study for more than 15 years. There are several crop rotation systems that have been studied which have been based upon the type of soil, type of farm equipment and location in reference to markets. The particular rotation to be described was started three years ago. The soil has been classified as a Delanco sandy loam. It is underlain by clay between approximately the 36- and 42-inch depth and sand and gravel below this depth. The soil has the power to hold (according to laboratory methods) about four milion pounds of water per acre. However, this amount of water is seldom, if ever, realized in the soil profile. It had received no fertilizer for a number of years previous to the establishing of the rotation and was prolifically populated with various grass seed.

To begin the rotation the soil was limed with two tons of dolomitic limestone and fertilized with 1,000 pounds of 5-10-10 fertilizer broadcast. The rotation consisted of tomatoes followed by grain interseeded with legumes, corn then tomatoes again.

The tomatoes received most of the fertilizer which averaged 1,500 pounds of 5-10-10 per acre. The fertilizer carried 10 pounds of borax per ton and was approximately neutral with dolomite. It was applied by putting 500 pounds in bands at planting time or under the row, followed by supplemental sidedressing applications. Supplemental applications of nitrogen, which consisted of 150 pounds of ammonium nitrate, were necessary on tomatoes in two of the three years.

Grain followed the tomatoes without additional fertilizer. In the spring the field was seeded to red clover. The grain was combined and the straw allowed to remain on the field.

The hybrid corn which followed received 250 pounds of 5-10-10 fertilizer in bands at planting time as a starter fertilizer and 300 pounds of cyanamid broadcast immediately after planting for supplemental nitrogen and partial weed control. At the "knee-high" stage, it received 300 pounds of ammonium nitrate at which time cultivation was stopped. The stand of corn varied between 12,000 and 24,000 stalks per acre. The most practical stand seems to be 12,000 to 15,000 stalks per acre.

In this rotation a winter protective cover crop of rye followed the corn. The stalks and all of the fodder were returned for organic matter.

The yields, on the acre basis, have been as follows:

Tomatoes: 1949, 15 tons; 1950, 18 tons and 1951, 24½ tons.

Corn: 1949, 102 bu.; 1950, 109 bu. and 1951, 76 bu.

Grain: 1949, 78 bu. oats; 1950, 31 bu. rye; 1951, 43½ bu. wheat.

During the three-year period considerable organic matter was added to the soil. Organic matter content of the plowed layer was increased from 1.4 per cent to 1.7 per cent. This was an increase of approximately 600 pounds of nitrogen per acre. A better physical condition in the soil was established without irrigation.

No Spraying

No spray materials were required for the other crops. It is believed that limiting the spray program to one year of three or more will eliminate the possibility of toxic spray residue in the soil. It is recognized now that this is becoming an increasingly disturbing problem in agriculture. Some spray materials do not readily decompose in the soil thus tending to build up the toxic concentrations.

Figuring on the basis of present day prices, the economics of this rotation can readily be appreciated when it is realized that this year the grain would gross approximately $98, the corn $99 and the tomatoes $815 per acre. This averages approximately $337 per acre per year. Crop rotation therefore not only improves the soil, but is very profitable.

A crop rotation system based on sound economical procedures establishes a sound and steady economy. The grower is using a practice that virtually guarantees a long time plan in which he does not switch from one crop to another based on a flexible market.

His cropping practices therefore influence the economy of the country in that a more stable plan of supplying all the necessary requirements can be met in an orderly fashion.

Crop rotation as described here based upon years of observation and study is being used by a large number of successful growers. ◆

Sauchelli Writes Phosphate Book

Phosphorus is the all-important essential constituent of all living organisms in general and of vegetable tissues in particular. Phosphorus in agriculture is the story of the indispensable ingredient—without it, agriculture is inconceivable.

So writes Vincent Sauchelli, director of agricultural research, Davison Chemical Corporation, in a new book on the element, called "Manual on Phosphates in Agriculture."

The manual was prepared primarily to serve the Davison organization, but in response to numerous questions and requests concerning the use of phosphates and superphosphates, it is available to others.

The manual traces the history of phosphorus, where it is found and in what forms. Charts and photographs are included to illustrate the text material.

Chapters deal with mining of phosphate rock, processing of the rock, granulation; fixation of phosphates, rock phosphate versus superphosphate and many other topics, including radiophosphorus and the use of tagged atoms to trace the uptake of phosphorus by plants from rock phosphate and superphosphate.

The book contains 171 pages of text and a bibliography.

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LION AMMONIUM NITRATE FERTILIZER— The improved spherical white pellets in this product contain a guaranteed minimum of 33.5% nitrogen. They flow freely, resist caking and store much better. Lion Ammonium Nitrate Fertilizer is shipped in 100-pound, 6-ply bags with two moisture-proof asphalt layers.

LION SULPHATE OF AMMONIA— This new, superior-type sulphate is guaranteed to contain a minimum of 21% nitrogen. Through special conditioning of the larger crystals, moisture and free acid content is greatly reduced. These factors, together with the special coating applied, make for greater resistance to caking in shipment or in storage. This product flows freely. It is shipped in bulk and in 100-pound, 6-ply bags laminated with asphalt.

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Free Information

On each of the two postage-paid postcards below you can request further information on four items described on this and the Industrial News section of this issue. *Fill out one quarter section for each item in which you are interested.*

2-4 Odor Mask

"Scents mean dollars!" the Albek corporation declares in literature describing Odormasque P which is useful in masking un-pleasant insecticide odors. Particular problems of manufacturers who want to hide unpleasant odors in their products will be handled by the firm.

2-5 Protective Aprons

Positive protection against abrasion, oils, greases, acids and alkalis is assured by using "Protectocote" neoprene latex aprons, according to American Optical company in a new booklet. The apron is saturation-coated. The fabric is impregnated with neoprene latex for longer protection and wear. What's more, the company explains, it won't crack, blister or peel and is not affected by extreme heat, moisture or cold.

2-6 2,4-D Solubizer

If formulation of that potent weed killer, 2,4-D is your business, you may be interested in a solubizer for the herbicide manufactured by Sharples company. The firm produces a product called "Sharsol" which can be used as a solubizer for 2,4-D acid it says in recent literature.

2-7 Hyster Trucks

You can slash materials handling costs in your plant by using Hyster industrial trucks, the firm declares. Lift trucks, straddle trucks, Karry Kranes and turret trucks all are made by the company for fertilizer and other manufacturers, according to a bulletin.

2-8 Entoleter Mixer

A new centrifugal machine designed to provide thorough mixing and blending in faster time at reduced cost is described by the Entoleter company. The

Here is a list of the NEW PRODUCTS and BULLETINS described on this and the Industrial News pages of this issue giving their monthly code number.

- 2-1 Improved Chain Belt
- 2-2 Overload Release
- 2-3 Hand Pads
- 2-4 Odor Mask
- 2-5 Protective Aprons
- 2-6 2,4-D Solubizer
- 2-7 Hyster Trucks
- 2-8 Entoleter Mixer
- 2-9 Sulfur Collector
- 2-10 Rust-Oleum
- 2-11 Hudson Sacks
- 2-12 Jeffrey Conveyors
- 2-13 Aurora Pump
- 2-14 Flow Meter
- 2-15 Perma-Plate
- 2-16 'Vibrolator'

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FARM CHEMICALS Code Number
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"Entoleter" mixer is producing amazingly uniform mixtures, simply and economically in chemical process plants, the company claims. It requires only 12 cubic feet and has a capacity of 12,000 pounds of finished mix per hour. The company says the unit, in use in fertilizer and pesticide plants, destroys all stages of insect life where beetle or similar insect infestation may be present.

2-9 Sulfur Collector

Collecting sulfur after it has been reduced to particle size requires a dust collector that can stand up under repeated inherent processing explosions. The American Wheelabrator and Equipment Company says it has a Dustube collector that will do the job under these conditions. Literature from the company describes a collector which withstands explosions without damage to the equipment. The equipment serves both as a materials handling and recovery unit. It collects sulfur from micronizer mills and feeds it by gravity to the packing department.

2-10 Rust-Oleum

Thousands of dollars in maintenance costs are spent every year by fertilizer and pesticide plants. Part of this money goes toward replacing metal equipment that has rusted. Rust-Oleum corporation has a way to prevent this. By using their rust-preventive metal surfaces can be made safe from dust, fumes, rain, moisture heat and general weathering, the company states, in a bulletin. The substance may be applied directly over surfaces already rusted without removing all the rust. Thus, costly sandblasting and chemical re-cleaning usually are not required

2-11 Hudson Sacks

You can be sure of delivery when you order from Hudson. That's what the company claims in literature about its multi-wall sacks. The reason: the company is its own supplier; an unbroken chain runs from forest to finished product to the buyer. Their sacks are always strong and uniform and are built to exact specifications.

2-12 Jeffrey Conveyors

Special conveying machinery for handling all types of industrial material is described in a bulletin of the Jeffrey company. Bulk materials in a fertilizer plant may be handled with a steel apron conveyor for horizontal and inclined conveying. Loose material, such as barrels, boxes and crates can be carried on a wood apron conveyor while a scraper flight conveyor may be used for handling bulk material horizontally or on an incline, discharging at fixed points in trough bottom. A special "mass-flo" elevator conveyor handles many classes of free flowing bulk material in a vertical, inclined or horizontal direction, or in a combination of directions. It can be fed at one or more points along its run.

2-13 Aurora Pump

The problem of handling liquids and chemical solutions can be solved by using an Aurora pump, the company states in a recent catalog. In cases where small capacities and high heads predominate, it explains, the pump is especially adaptable. Pumps are available in capacities to 4000 g.p.m. with heads to 300 feet. Type OD, for instance, has a horizontally split case, and double suction. It is a single stage centrifugal pump.

2-14 Flow Meter

If you're interested in automatic controlling of the flow of a chemical solution you will be benefited by using a Bristol flow meter. The meters, described in a new bulletin are instruments for recording, integrating, indicating, automatic controlling and telemetering of steam, water, gas, oil and chemical mixtures.

Mechanical and electrical flow meters are described in the booklet, which contains photographs and reproductions of actual recording charts and sketches of typical methods of applying the instruments. The meters have wide application in industrial plants and in process control work.

2-15 Perma-Plate

You can have one million fingers ready to do an iron removing job if you have a Dings Perma-Plate magnet handy, the manufacturer states. The magnet has many uses for the separation of magnetic substances and keeping metal out of substances in process. The Perma-Plate handles solids or liquids, withstands high temperatures and can be installed anywhere, according to information in a new catalog describing the product.

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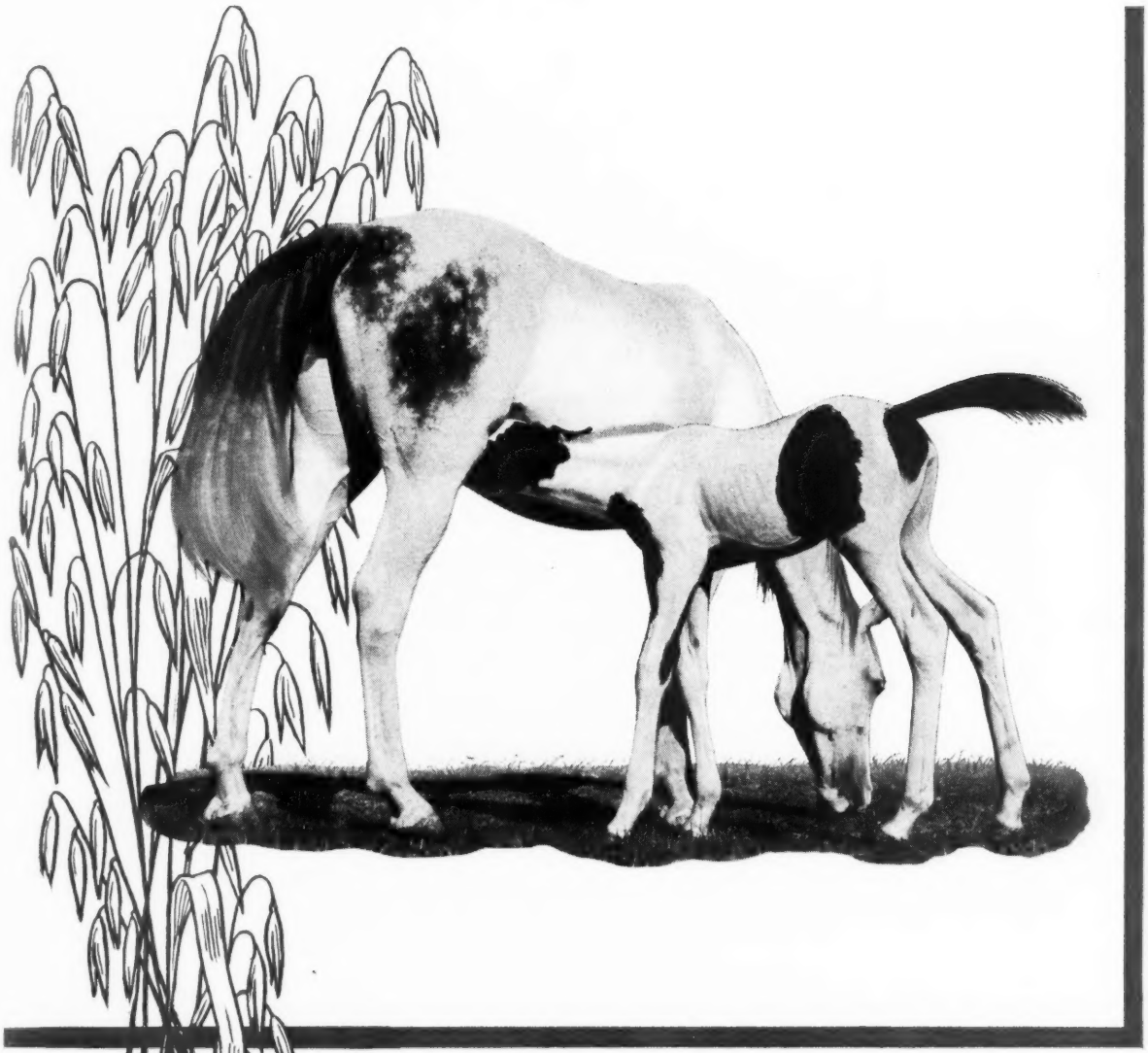
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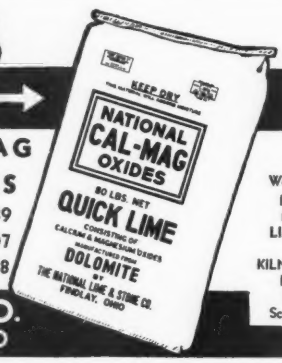
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AGRICULTURAL CONSULTANTS
Bailey & Lerch, Washington, D. C.

ALDRIN
Ashcraft-Wilkinson Co., Atlanta, Ga.

AMMONIA—Anhydrous and Liquor
Barrett Div., Allied Chemical & Dye Corp., New York City
Commercial Solvents Corp., New York City
Lion Oil Co., El Dorado, Ark.
Phillips Chemical Co., Bartlesville, Okla.
Spencer Chemical Co., Kansas City, Mo.

AMMONIUM NITRATE
Ashcraft-Wilkinson Co., Atlanta, Ga.
Lion Oil Co., El Dorado, Ark.
Phillips Chemical Co., Bartlesville, Okla.
Spencer Chemical Co., Kansas City, Mo.

AMMONIUM SULFATE
See Sulfate of Ammonia

BAGS—Burlap
Bemis Bros. Bag Co., St. Louis, Mo.
Mente & Co., Inc., New Orleans, La.
Virginia-Carolina Chemical Corp., Richmond, Va.

BAGS—Cotton
Bemis Bro. Bag Co., St. Louis, Mo.
Mente & Co., Inc., New Orleans, La.
Virginia-Carolina Chemical Corp., Richmond, Va.

BAGS—Multiwall-Paper
Bemis Bro. Bag Co., St. Louis, Mo.
International Paper Co., Bagpak Div., New York City
Hammond Bag & Paper Co., Wellsburg, W. Va.
Jaite Company, The, Jaite, Ohio
Kraft Bag Corporation, New York City
Mente & Co., Inc., New Orleans, La.
Raymond Bag Co., Middletown, Ohio
Union Bag & Paper Corp., New York City
Virginia-Carolina Chemical Corp., Richmond, Va.

BAGS—Dealers and Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
McIver & Son, Alex, M., Charleston, S. C.

BAG CLOSING MACHINES
International Paper Co., Bagpak Div., New York City

BAG CLOSING—THREAD & TWINE
Bemis Bros. Bag Co., St. Louis, Mo.
Mente & Co., Inc., New Orleans, La.

BAG PRINTING MACHINES
Schmutz Mfg., Louisville, Ky.

BAG FILLING MACHINES
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

BHC
Ashcraft-Wilkinson Co., Atlanta, Ga.
Commercial Solvents Corp., New York City

BONE PRODUCTS
American Agricultural Chemical Co., New York City
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Ashcraft-Wilkinson Co., Atlanta, Ga.
Jackle, Frank R., New York City
McIver & Son, Alex M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

BORAX AND BORIC ACID
American Potash and Chem. Corp., New York City
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

BROKERS
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Jackle, Frank R., New York City
Keim, Samuel D., Philadelphia, Pa.
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

BUCKETS—Hoist, Crane, etc.
Hayward Company, The, New York City

CALCIUM ARSENATE
American Agricultural Chemical Co., New York City

CARS AND CART
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

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Ashcraft-Wilkinson Co., Atlanta, Ga.
McIver & Son, Alex. M., Charleston, S. C.

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Shuey & Company, Inc., Savannah, Ga.
Wiley & Company, Baltimore, Md.

CHLORDANE
Ashcraft-Wilkinson Co., Atlanta, Ga.

CLAY
Ashcraft-Wilkinson Co., Atlanta, Ga.

CONDITIONERS
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Jackle, Frank R., New York City
Keim, Samuel D., Philadelphia, Pa.
McIver & Son, Alex. M., Charleston, S. C.
National Lime & Stone Co., Findlay, Ohio

CONTROL SYSYEMS
Sackett & Sons Co., The A. J., Baltimore, Md.

CONVEYORS—Belt
Sackett & Sons Co., The A. J., Baltimore, Md.

COPPER SULFATE
Andrews Sales, Inc., W. R. E., Philadelphia, Pa.
Tennessee Corp., Atlanta, Ga.

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Ashcraft-Wilkinson Co., Atlanta, Ga.
Jackle, Frank R., New York City
McIver & Son. Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

DDT
Ashcraft-Wilkinson Co., Atlanta, Ga.
Monsanto Chemical Co., St. Louis, Mo.

DIELDRIN
Ashcraft-Wilkinson Co., Atlanta, Ga.

DILAN
Commercial Solvents Corp., New York City

DILUENTS
Ashcraft-Wilkinson Co., Atlanta, Ga.

DRYERS
Sackett & Sons Co., The A. J., Baltimore, Md.

ELEVATORS—Bucket
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

ENGINEERS—Chemical and Industrial
Chemical Construction Corp., New York City
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Marietta Concrete Corporation, Marietta, Ohio
Sackett & Sons Co., The A. J., Baltimore, Md.
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Titlestad Corporation, Nicolay, New York City

FERTILIZER—Mixed
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Armour Fertilizer Works, Atlanta, Ga.
Davison Chemical Corporation, Baltimore, Md.
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Southern States Phosphate & Fertilizer Co., Savannah, Ga.
Virginia-Carolina Chemical Corp., Richmond, Va.

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FISH SCRAP AND OIL
Ashcraft-Wilkinson Co., Atlanta, Ga.
Jackle, Frank R., New York City
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

FULLER'S EARTH
Ashcraft-Wilkinson Co., Atlanta, Ga.

FUNGICIDES
American Agricultural Chemical Co., New York City
Andrews Sales, Inc., W. R. E., Philadelphia, Pa.
Tennessee Corp., Atlanta, Ga.

HERBICIDES
Lion Oil Company, El Dorado, Ark.
Monsanto Chemical Co., St. Louis, Mo.

HERBICIDES—Oils
Lion Oil Company, El Dorado, Ark.

HOPPERS & SPOUTS
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

IMPORTERS, EXPORTERS
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Southern States Phosphate & Fertilizer Co., Savannah, Ga.
Woodward & Dickerson, Inc., Philadelphia, Pa.

INSECTICIDES
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Andrews Sales, Inc., W. R. E., Philadelphia, Pa.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Commercial Solvents Corp., New York City
Powell & Co., John. New York City
Virginia-Carolina Chemical Corp., Richmond, Va.

IRON SULFATE
Tennessee Corp., Atlanta, Ga.

LEAD ARSENATE
American Agricultural Chemical Co., New York City

LIMESTONE
American Agricultural Chemical Co., New York City
Ashcraft-Wilkinson Co., Atlanta, Ga.
McIver & Son, Alex. M., Charleston, S. C.
National Lime & Stone Co., Findlay, Ohio

LOADERS—Car and Wagon
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making and Handling
Atlanta Utility Works, The, East Point, Ga.
Chemical Construction Corp., New York City
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

MACHINERY—Acidulating
Chemical Construction Corp., New York City
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Ammoniating
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Grinding and Pulverizing
Atlanta Utility Works, The, East Point, Ga.
Bradley Pulverizer Co., Allentown, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

MACHINERY—Material Handling
Atlanta Utility Works, The, East Point, Ga.
Hayward Company, The, New York City
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

MACHINERY—Mixing, Screening and Bagging
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

MACHINERY—Power Transmission
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

MACHINERY—Superphosphate Manufacturing
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

MANGANESE SULFATE
McIver & Son, Alex. M., Charleston, S. C.
Tennessee Corp., Atlanta, Ga.

MANURE SALTS
Potash Co. of America, New York City

MINOR ELEMENTS
Andrews Sales, Inc., W R., E., Philadelphia, Pa.
Tennessee Corporation, Atlanta, Ga.

MIXERS
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Barrett Div., Allied Chemical & Dye Corp., New York City
International Minerals & Chemicals Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

NITROGEN SOLUTIONS
Barrett Div., Allied Chemical & Dye Corp., New York City
Lion Oil Company, El Dorado, Ark.
Phillips Chemical Co., Bartlesville, Okla.
Spencer Chemical Co., Kansas City, Mo.

NITROGEN MATERIALS—Organic
American Agriculture Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
International Minerals & Chemical Corporation, Chicago, Ill.
Jackle, Frank R., New York City
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

NOZZLES—Spray
Monarch Mfg. Works, Philadelphia, Pa.
Spraying Systems Co., Bellwood, Ill.

PARATHION
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Monsanto Chemical Co., St. Louis, Mo.

PENTACHLOROPHENOL
Monsanto Chemical Co., St. Louis, Mo.

PHOSPHATE ROCK
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
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Woodward & Dickerson, Inc., Philadelphia, Pa.

PHOSPHORIC ACID
American Agricultural Chemical Co., New York City

PLANT CONSTRUCTION—Fertilizer and Acid
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Fairlie, Inc., Andrew M., New York City
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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.
Titlestad Corporatian Nicolay, New York City

POTASH—Muriate
American Potash & Chemical Corp., New York City
International Minerals & Chemical Corp., Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
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POTASH—Sulfate
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Potash Co. of America, New York City

PRINTING PRESSES—Bag
Schmutz Mfg. Co., Louisville, Ky.

PYROPHYLLITE
Ashcraft-Wilkinson Co., Atlanta, Ga.

REPAIR PARTS AND CASTINGS
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

SACKING UNITS
Sackett & Sons Co., The A. J., Baltimore, Md.

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Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

SCREENS
Atlanta Utility Works, The East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman Foundry and Machine Co., Aurora, Ind.

SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Spraying Systems Co., Bellwood, Ill.

STORAGE BUILDINGS
Marietta Concrete Corporation, Marietta, Ohio

SULFATE OF AMMONIA
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Barrett Div., Allied Chemical & Dye Corp., New York City
Jackle, Frank R., New York City
Koppers Co., Inc., Tar Products Div., Pittsburgh, Pa.
Lion Oil Co., El Dorado, Ark.
McIver & Son, Alex. M., Charleston, S. C.
Phillips Chemical Co., Bartlesville, Okla.
United States Steel Corp., New York City
Woodward & Dickerson, Inc., Philadelphia, Pa.

SULFATE OF POTASH—MAGNESIA
International Minerals & Chemicals Corporation, Chicago, Ill.

SULFUR
Ashcraft-Wilkinson Co., Atlanta, Ga.
Texas Gulf Sulphur Co., New York City
Ashcraft-Wilkinson Co., Atlanta, Ga.
Woodward & Dickerson, Inc., Philadelphia, Pa.

SULFUR—Dusting & Spraying
Ashcraft-Wilkinson Co., Atlanta, Ga.
U. S. Phosphoric Products Div., Tennessee Corp., Tampa, Fla.

SULFURIC ACID
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
International Minerals & Chemical Corporation, Chicago, Ill.
Lion Oil Company, El Dorado, Ark.
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Virginia-Carolina Chemical Corp., Richmond, Va.

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Ashcraft-Wilkinson Co., Atlanta, Ga.
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International Minerals & Chemical Corporation, Chicago, Ill.
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Woodward & Dickerson, Inc., Philadelphia, Pa.

TEPP
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TOXAPHENE
Ashcraft-Wilkinson Co., Atlanta, Ga.

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Monsanto Chemical Co., St. Louis, Mo.

2, 4, 5-T
Monsanto Chemical Co., St. Louis, Mo.

UREA & UREA PRODUCTS
Barrett Div., Allied Chemical & Dye Corp., New York City

VALVES
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Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.

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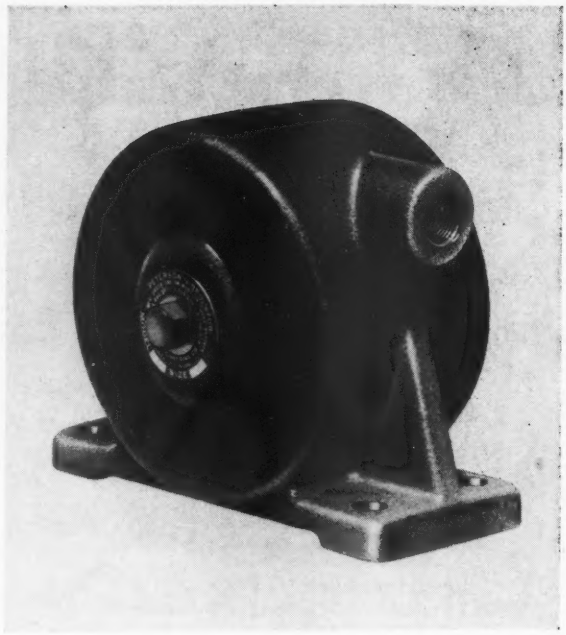
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